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JOURNAL
OF
AGRICULTURE
OF
WESTERN AUSTRALIA

Published Quarterly
by direction of
The Minister for Agriculture
Hon. G. B. Wood

Vol. XXVIII (Second Series) No. 4

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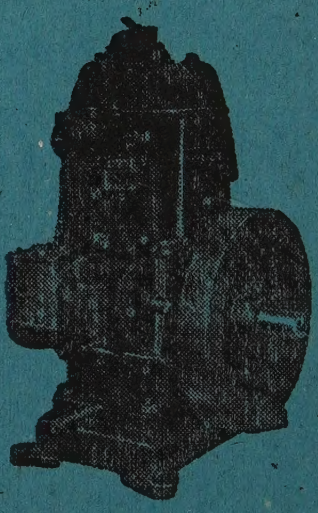

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Western Australia

JOURNAL

OF THE

DEPARTMENT OF AGRICULTURE

OF

WESTERN AUSTRALIA

Issued by Direction of

THE MINISTER FOR AGRICULTURE
Hon. G. B. WOOD

PUBLISHED QUARTERLY

All exchanges and correspondence should be addressed to
THE DIRECTOR, DEPARTMENT OF AGRICULTURE
PERTH, WESTERN AUSTRALIA.

EDITOR — J. A. MALLETT

DECEMBER, 1951

By Authority: WILLIAM H. WYATT, Government Printer, Perth.

1951

50599/12/51

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JOURNAL

OF THE

Department of Agriculture

OF

WESTERN AUSTRALIA

Vol. 28. (Second Series) DECEMBER, 1951. No. 4.

Cultivation of Tobacco in Western Australia

J. M. ALLAN, Officer in Charge Tobacco Industry

HISTORICAL

Although small plots of tobacco were probably grown in Western Australia for home consumption from the early days of settlement, cultivation of the crop as a commercial industry is of comparatively recent origin. Records show that small plots were planted in various parts of the State from time to time, to explore the possibility of establishing the industry. However, it was not until 1923 that the first concerted efforts were made with experiments and exploratory plots to ascertain if commercially valuable tobacco could be grown. Over the next few years it was determined that tobacco leaf of satisfactory quality could be produced in several districts of the lower South-West.

The birth of the industry as a commercial proposition can be regarded as dating from 1930. In that year 25 acres were planted for a yield of 12,500 lb. of cured leaf. In the following year the area increased to 348 acres, from which 211,230 lb. of tobacco leaf was produced. Over the next few years the area fluctuated and it was not until 1936 that it increased to over 1,000 acres. Up until 1940 the average tobacco acreage was a little over 1,000 for an average production of approximately 740,000 lb.

In 1940, when due to enemy action it appeared that Australia might be cut off from overseas tobacco leaf supplies, an appeal was made for increased production. The acreage planted to tobacco steadily expanded until in the 1942-1943 season, it reached a peak with 1,579 acres from which 1,335,557 lb. of tobacco leaf was harvested.

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From 1943 war-time influences began to react against tobacco production. Enlistment in the armed services and the call-up of aliens for labour corps greatly reduced the labour pool available to the industry. Also, the need for the production of essential foodstuffs to feed our own and allied fighting forces diverted many growers from tobacco to food production. Attractive contract prices were offered as an incentive to obtain these much needed foodstuffs and food production became more profitable than tobacco growing. This trend was further assisted by the incidence of unfavourable tobacco growing seasons in 1943-1944 and 1944-1945. Production of tobacco reached its lowest ebb with the 1945-1946 crop, when only 296 acres were planted.

Since the 1946-1947 crop, expansion of the area planted to tobacco has been slow but steady. A rapid increase in tobacco production has been hampered by shortage of labour and materials. With the 1950-1951 crop tobacco acreage has returned to almost 1,000 acres, with a further trend towards increased production. The rate of expansion has been controlled by the supply of essential materials.

In pre-war years State average production varied little from 700 lb. per acre, although individual crops of 1,000 lb. per acre were by no means uncommon. Since the war, improved cultural practices and the elimination of unsuitable soils and less suitable varieties has increased average yield to more than 800 lb. per acre, with an upward trend over the past three years. Many growers consistently produce an average yield of 1,000 to 1,500 lb. per acre, figures which compare favourably with other tobacco growing districts in Australia and other parts of the world.

Plate 1
Well-grown crop of tobacco not yet "topped" and partly harvested. Curing kilns and grading shed in the background
—Photo. by Govt. Photographer.

CROP ENVIRONMENT

The factors that determine the suitability of an area for tobacco growing are climate, suitable soil and adequate moisture for the growth of the crop over its effective lifetime. So far a suitable combination of these factors have been found only in a comparatively restricted area in the lower South-West of the State. Climatic aspects definitely exclude the d ier parts of the State, from economic tobacco production. The only other probable area in which tobacco might be grown would be the far North-West.

Climate.

Tobacco is of tropical origin and makes its most rapid growth under climatic conditions approaching those of its natural habitat. However, the crop is grown over a wide range of conditions and its culture extends from Central Sweden in the north to as far south as New Zealand. Irrespective of the range of conditions under which the crop is grown, certain attributes of climate are essential during the growing period of the crop.

It is generally recognised that a suitable climate is the first essential for the production of commercially valuable tobacco. The ideal conditions for the growth and proper maturation of the tobacco plant are freedom from frost, an abundant and evenly distributed rainfall, fairly high temperatures, high atmospheric humidity, and abundance of cloudy weather and absence of hot drying winds.

Climatic conditions in the lower South-West of Western Australia are far from the ideal. Over the area in which it is considered tobacco may be grown, rainfall varies from 40 to more than 50 inches per annum, but it is seldom that more than five to six inches falls within the growing period of the crop, October to mid-March inclusive. This deficiency of moisture for the crop has to be made up by other means. During October, November and generally well into December, over which period the crop is transplanted into the field and makes most of its growth, the weather is characterised by relatively high humidity, frequent light rains, many cloudy days and warm but not very hot temperatures. From December to the middle of March relatively hot weather is generally experienced with little rain and few cloudy days. Occasionally hot dry winds are experienced during the day and sometimes sharp falls in temperature at night. Thus, it will be seen that the Western Australian tobacco grower has to contend with weather conditions that differ widely from the general conception of a perfect tobacco growing climate. If he is to produce the type of leaf required by the market he must see that the location of his crop and his cultural methods are such as to offset as far as possible the climatic deficiencies.

In the map of the lower portion of the State (Fig. 1), is shown the probable tobacco growing belt of the South-West of Western Australia. The rough limits of this area are from Denmark on the south coast to a depth of 40 miles inland and then on a line through a little north of Manjimup to the west coast. The belt then extends northward up the west coast as far as Busselton, but only to a depth of approximately 20 miles inland. This belt is defined largely by higher atmospheric humidity and comparative freedom from hot drying

Fig. 1

Map of the South-West corner of Western Australia showing the probable tobacco belt. The dotted line marks the inland boundary

winds during the life of the crop in the field. For some distance east of this belt suitable conditions occur for the crop, but the country is rather open and exposed to winds. Tobacco might be grown there successfully in locations suitably sheltered by topographical features. Although tobacco is not grown commercially throughout this belt, its suitability has been proved on certain soils within the area by exploratory plots. Outside this area, irrespective of an abundant supply of water for the growth of the crop, leaf produced is generally of harsh, coarse texture and of low commercial value.

Soils.

The second factor, which is recognised as extremely important in the production of high quality tobacco, is soil of the right type. Bright flue-cured tobacco of the quality which is in the greatest demand today, is generally best grown in a light sand to sandy loam soil of comparatively low fertility. It is desirable that it be underlaid by a clay subsoil to a depth of 18 to 30 inches, to retain moisture. There are large areas of such soils within the defined belt and there is considerable scope for expansion of the industry.

The careful selection of land is important. At present, it is impossible to say definitely without an actual trial whether a particular area of soil will produce high quality tobacco, but if certain considerations are taken into account there is every possibility of success. The soil should be a free-working sand or sandy loam and it should be well drained. It may vary in colour from yellow to grey, brown or red. Very often the lightest coloured soils produce the brightest tobacco. Black sand or peaty soils should be avoided. Depressions from which there is little drainage should also be avoided, as salt often accumulates in such areas. A short-fractured yellow or brown mottled clay subsoil at a depth of 18 to 30 inches is a fairly reliable guide that the soil will retain sufficient moisture. Some tobacco soils contain a proportion of gravel, but except under exceptional conditions gravelly soils do not retain moisture well. The presence of gravel in the subsoil is no great fault, so long as it is associated with sufficient clay. Soils which have a high clay fraction in the top layer seldom produce high quality tobacco. The most suitable soils are generally found on gentle slopes and flats between the undulating ridges which are a feature of south-western topography.

Water.

Under favourable conditions, tobacco tends to develop an enormous leaf area within a short period and to do this an ample supply of soil moisture is necessary. To compensate for the lack of rainfall over the summer months some other means must be found to meet the requirements of the crop. Within the established tobacco belt, very extensive areas of suitable soils occur, but large areas do not carry sufficient moisture over the growing and maturation period of the crop, therefore the selection of a soil is as equally dependent on its moisture relationship as the soil type itself.

In the general topography of the lower South-West, undulations create shallow valleys between low ridges. Where the country is underlaid by a retentive clay subsoil, winter rainfall is retained in the soil and drains away slowly, particularly where the slopes are gentle. Seepage of moisture tends to be from the hills or ridges into the valleys and flats. Under these conditions, after the cessation of the rains the country dries out on the tops of the ridges first, then down the steep slopes and at a decreasing rate down the more gentle slopes into the flats. With a retentive subsoil the more gentle slopes and flats frequently hold sufficient moisture for long enough to permit the growth of tobacco and other summer crops.

Tobacco requires ample moisture to permit full growth of the crop, then as the plant matures and the leaf is harvested, the crop can make do with a decreasing water requirement. However, if leaf quality is to be maintained there must be sufficient moisture to keep the leaves of the plant sufficiently turgid at all times. Therefore, the areas in which tobacco is grown in Western Australia are selected on soil type and are delineated by how long the soil moisture is retained. Generally the flats in the valleys are suitable and planting up the gentle slopes can be continued only as far as the point where sufficient moisture is retained for long enough for the plant's requirements.

Crops grown on hillside land or land in which insufficient water is retained, suffer considerably from drought, do not mature properly and generally only yield a small proportion of leaf of satisfactory quality. On the other hand tobacco will not do well on waterlogged or poorly drained land. The importance of soil aeration for the tobacco plant cannot be stressed too strongly. If aeration of the soil is prevented by excess water, the plant will not make proper growth and a very poor crop will result.

Where a suitable water supply exists, deficiency of rainfall may be supplied by irrigation, but where naturally moist soil is available both labour and production costs of the crop are greatly reduced.

Plate 2

Irrigated tobacco crop being watered by a modern spray method
—Photo. by Govt. Photographer.

If it is necessary to use irrigation to meet the water requirement of the tobacco crop, it is essential to make certain that the water supply is sufficient and free from salt and that the soil used will retain the moisture applied for sufficiently long a period. To obtain satisfactory yield and quality from irrigated tobacco, the crop must never receive a check, due to too long an interval between waterings. Therefore, the sequence of watering must be worked out so that the soil never becomes dry. Irrigation should begin before moisture retained after the seasonal rains is exhausted to the point where it may have a retarding effect on the growth of the crop. The land should be watered as often as necessary until the crop begins to mature. The quantity of water applied at any one time should be equal to from half to one inch of rain depending on soil type. If on a fairly retentive

soil, irrigation may be discontinued after a final watering given at a time when the first leaves commence to show signs of ripeness. If this procedure is adopted harvesting must be completed without further waterings. If a watering was to be given after harvesting had commenced and after the soil had dried out too much, the crop would commence to grow again, leaf would cease to ripen for two or three weeks and leaf harvested subsequently would be of indifferent quality. An alternative is not to discontinue watering when maturity begins, but to irrigate when required until harvest is completed. If the soil is not allowed to dry to the point where a check in growth is experienced maturity will not be affected.

THE TOBACCO PLANT.

There are two species cultivated for the production of smoking tobacco, *Nicotiania tabacum* and *N. rustica*. Only *N. tabacum* is grown in Australia. It belongs to the Natural Order, Solanaceae, to which also belongs the tomato and potato. It is an annual plant and is propagated in seed-beds and transplanted into the field when about four inches high. It is a summer growing plant, usually planted out in this State during October and November and harvested during January to March. After harvesting the leaf is subjected to a curing process, during which it undergoes chemical changes and a large proportion of the natural moisture is extracted. There are a number of different curing methods, each of which produces tobacco of distinctive type and smoking characteristics. The demand in Australia is for tobacco of the "Virginia" type. This is tobacco produced by a heat process known as "flue curing" from particular varieties. The tobacco produced under this process is a bright coloured, fine textured leaf of mild smoking quality suitable for cigarettes and fine cut tobacco.

Varieties.

There are hundreds of varieties of flue-cured tobacco in use in the many tobacco growing districts of the world. The selection of the most suitable varieties for the particular environment in which the crop is to be grown is of the utmost importance, and has a major influence on the yield and quality of leaf produced.

Many varieties have been tested in field experiments by the Department of Agriculture at Manjimup Tobacco Research Station and quite a number have enjoyed varying popularity with growers in the past. Among varieties that were grown commercially in this State were "Hickory Prior," "Cash," "Kelly," and "Sport." However, all have been superseded by the locally developed variety "Cross Hickory," which is now grown almost exclusively.

The origin of "Cross Hickory" is somewhat obscure. It is suspected that the variety originated from an accidental cross between the previously extensively grown "Hickory Prior" and a Mediterranean variety. Among the earliest Western Australian commercial growers were European migrants of Balkan origin. When they came to Australia they brought a little seed of tobacco varieties grown in their own countries and planted the seed here, very often alongside a crop of

"Hickory Prior." The introduced varieties proved unsuited to Australian conditions. Later one of the more careful growers noticed a number of plants among his crop which had the commercial qualities of "Hickory Prior" but with much bigger and broader leaves. He continued to select seed from this type of plant and gradually the variety "Cross Hickory" was evolved. The fact that plants closely allied to each of the suspected parents occurred in the resultant crop gave a fairly definite clue to the origin of the variety. Seed of the new type of tobacco became widely distributed amongst growers. After some years the strain was taken over by the Department of Agriculture and after years of careful selection it has become very close to a fixed variety.

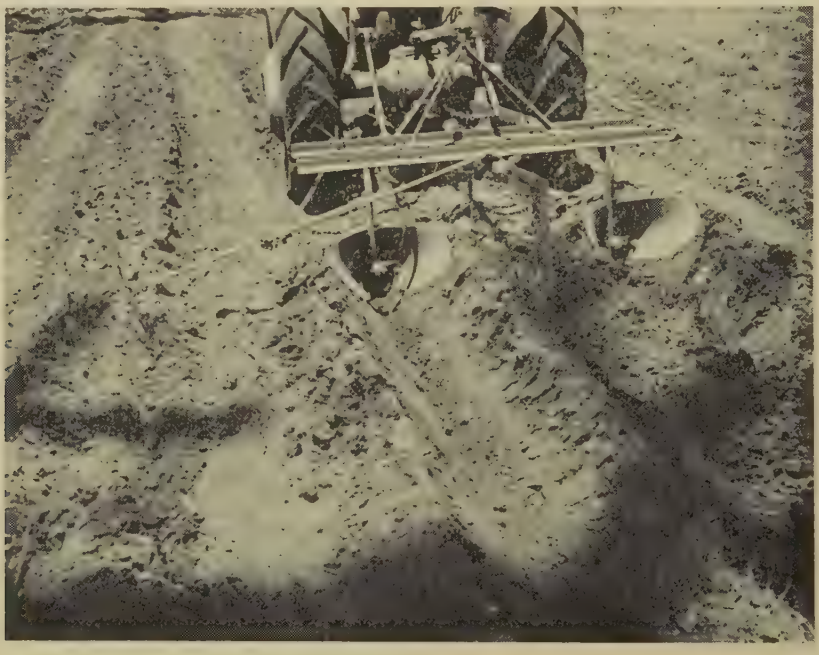

Plate 3
Power drawn ridger opening furrows for fertiliser, showing the type of broad open furrow required. Marker for position of next row is also shown
—Photo. by Govt. Photographer.

A series of new American varieties are at present under test by the Department. They are "400," "401," "402," "Hicks," "Virginia Gold," "Mammoth Gold" and "Yellow Special." Several of these varieties have given promising results over two seasons, but it is desired to test them still further before release to growers.

CULTURAL OPERATIONS

Selection and Preparation of Tobacco Land.

As already indicated, the careful selection of land for tobacco growing is most important. Guidance has been given to the selection of soil type and it must be borne in mind that the moisture relationship of the soil chosen, is equally as important as the soil itself. Topography of the country is generally the best guide as to where

suitable land might be located, and the best soils are generally to be found on the gentle slopes and flats between ridges. If the land is still virgin or only partly cleared, the presence of certain vegetation is an indication of retention of moisture for the required period. Such vegetation includes ti-tree, peppermint and other water loving scrub, certain species of banksia, various types of rushes and the common tall green kangaroo paw of the South-West. The presence of too many paper-bark trees or bottlebrush scrub generally means that the soil is too wet and will remain waterlogged. If the land is down in pasture, the length of time the pasture remains green into the summer will indicate the possibility of the land carrying tobacco crop through to maturity. The presence of paspalum, provided the land is not too wet, is an infallible guide to moisture holding capacity. Land carrying kikuyu grass, although generally moist enough should be avoided owing to the difficulty of eradication. The tobacco area should be selected with a view to shelter from strong winds, if in an area subject to wind of high velocity during the growing period of the crop. Tobacco leaf can be severely damaged by strong wind and if such damage is likely to occur, land selected should be sheltered by topographical features or standing timber. In new clearing for tobacco in windy areas, it is advisable to leave a belt of trees as protection from prevailing winds.

Generally speaking, newly cleared land of suitable type may be expected to yield satisfactory results from the viewpoint of both yield and quality. However, there is every prospect of both yield and quality improving if a mixed cereal and leguminous green manure crop can be ploughed in before planting. Land which has been for some years under pasture containing a fair percentage of leguminous species may give poor results. This is due to an accumulation of organic nitrogen from the roots of legumes, and it may have a disastrous effect on quality, in extreme cases even to rendering the leaf practically uncurable. Where it is desired to utilise such land for tobacco, a non-leguminous crop such as a cereal, potatoes, maize or turnips should first be grown to deplete the excess nitrogen.

Under the heavy rainfall conditions of the South-West, most valley soils become waterlogged over the winter months. Where the excess water does not drain away fairly rapidly with the advent of finer weather in the spring and the land does not dry out sufficiently to permit land prepartion at the right time, artificial drainage is indicated. Tobacco will not do well on poorly drained land and leaf produced is of poor burning quality. Additional land may be brought into tobacco production on "late" land greatly improved by the construction of a few open, slab or tile drains.

Preparation of land for tobacco should begin in the autumn. If the land is not to be sown down with a green manure crop, it should be ploughed deeply in April or May, as soon as the land is moist enough and any weed seeds have germinated. Surface drainage will be assisted where necessary, by ploughing in narrow lands, leaving a deep finishing furrow between lands. If the land is sloping or has any tendency towards erosion, washing of the soil is prevented by ploughing a series of contour furrows one or two chains apart, with staggered connecting furrows in the general direction of fall, to carry run-off.

The land may be left without further cultivation until the following August or September or as early in the spring as the land will carry implements. The land is then ploughed and if free from weed growth one spring ploughing may be sufficient. A further cross ploughing may be advisable shortly before final preparation for planting if the

Plate 4

Transplanting into the field. One operator dropping plants keeps two planters at work

—Photo. by Govt. Photographer.

land is still not free from weed growth. After the final ploughing, the land is cultivated down to a fine tilth. The benefits to be obtained from an autumn ploughing are considerable. With newly cleared land the turn over of the soil exposes it to the sun, wind and rain, with consequent sweetening, while on old lands weeds and insect pests are effectively checked by winter fallow.

Green Manuring.

Western Australian tobacco soils are naturally poor in humus. This is a distinct disadvantage, as both yield and quality of leaf is affected if the soil is deficient in decayed organic matter. This deficiency may be rectified by the growing and ploughing in of suitable green manure crops. There are numerous examples in the Manjimup district of land which produced comparatively low yields of indifferent quality tobacco when newly cleared, but which by green manuring was brought to the stage of producing high yielding crops of fine quality tobacco within a few years.

Crops for green manure may be divided into two classes, leguminous, such as field peas and lupins, and non-leguminous, such as oats and rye. The former, owing to their ability to fix nitrogen, not only enrich the soil in humus when ploughed in, but add materially to the supply of nitrogen within the soil. The latter, although useful for adding to the humus content of the soil, do not materially increase the soil nitrogen.

As previously mentioned it is not desirable that tobacco soils be too rich in nitrogen. For that reason the growing of wholly leguminous crops is not generally recommended. Mixed crops such as oats or rye together with field peas, lupins or clover give best results as green manure. Once the desired soil fertility is obtained, land may be cropped successfully with tobacco for a number of years, by growing green manure crops each autumn and ploughing them in in spring preceding planting the tobacco crop. Such a practice is open to objection from the aspect of disease and insect control and cannot be pursued indefinitely. However, as a temporary expedient, where sufficient suitable land has not yet been developed to permit of a longer crop rotation, green manuring enables successful continuous production.

Plate 5
Young tobacco crop which has been inter-row cultivated being hand-hoed between plants in the rows
—Photo. by Govt. Photographer.

To ensure the production of a large bulk of vegetable matter for ploughing in, green manure crops should be planted as soon after the commencement of the autumn rains as possible. This applies particularly to legumes, as they do not make their maximum growth unless the soil is still warm when the seed is planted. To ensure complete

rotting of organic matter, green crops should be ploughed in at least six weeks before the land is required for tobacco. The best stage for turning in legumes is when in full flower and for cereals while still soft and succulent before the straw toughens and becomes fibrous. Green manure crops may be improved and kept at a soft stage of growth by periodic grazing with stock, but always make sure that they have sufficient period of uninterrupted growth to make the necessary bulk of green material before it is time for ploughing in.

If either a pure cereal or a pure leguminous crop is to be grown the usual sowing rate is two bushels of seed per acre. Where a mixed crop is to be planted one bushel each of the cereal and of the legume is sown. A liberal dressing of superphosphate when planting, greatly improves crop growth.

Crop Rotation.

Although much work has been done and is still being carried out by the Department on the development of the most economic use of tobacco land and most suitable crop rotations, it is essentially a long term project and it may be many years before the best sequence of cropping is worked out. Present indications are that a rotation in which the land is cropped once with tobacco every three years is probably the most desirable. This rotation envisages the use of other summer cash crops in the sequence, combined with winter green manuring. Cash crops that have been successfully grown are sunflowers, early varieties of maize for grain, early varieties of soya beans and various types of beans for canning. The main obstacle to including such crops in the rotation are that they have a fairly heavy labour requirement and the labour commitment of the tobacco crop does not permit of much time being spent on other crops in the rotation. Other difficulties are that there is no harvesting machinery in the area for such crops and that owing to the small acreage that would be grown on each farm that acquisition of individual plant would not be economically justified. Moreover, at present in Western Australia, markets for these crops are not extensive. Although desirable from the aspect of soil fertility, fortunately from the viewpoint of control of disease and insect pests, long crop rotations are so far unnecessary. But the day may come when these aspects have to be taken into consideration.

Various forms of soil improvement have been practised by local tobacco growers in which green manure crops were turned in between crops of tobacco or the land allowed to revert to weeds or natural pasture for two or three years. Probably the most successful rotation practiced is to plant tobacco for two years without any intermediate crop, then the land is sown down with oats and subterranean clover; the oats are either fed off with stock or cut for hay and the clover ploughed in the following year as green manure preceding the next tobacco crop. In this manner land is used for tobacco for two years, and over the succeeding two years soil fertility is built up with the cereal and legume and some return is obtained from the pasturage of stock. Under this system it has been proved that adequate soil fertility has been maintained for tobacco and when practiced from the time the land is first cleared, a steady improvement has been maintained in the yield and quality of the tobacco crop.

A one year rotation which has been practised on Manjimup Tobacco Research Station, in which the yield and quality of the tobacco crop has been maintained and even showed slight improvement over a period of seven years, is annual cropping of the land with tobacco with a crop of lupins turned in between crops. Although such a practice is not recommended as a permanent system, it may be used as an expedient to carry on production while a farm is being developed and further land cleared and improved in fertility.

Fertiliser.

The fertiliser in general use in this State is a "complete" one, having an analysis of 3.3 per cent. nitrogen, 14.5 per cent. phosphoric acid and 5.7 per cent. potash. One third of the nitrogen is in the form of nitrate of soda to give the plants a quick start and the remaining two-thirds are as sulphate of ammonia. Phosphoric acid is supplied by superphosphate and the potash as sulphate of potash. On no account must muriate of potash be used, as it contains a high percentage of chloride which has a deleterious effect on the burning quality of leaf. The fertiliser may be mixed on the farm from the above ingredients according to percentage analysis, but as it is readily available in the made up form, the extra labour is hardly warranted.

Plate 6

Young tobacco crop recently "primed" of useless and damaged bottom leaves

—Photo. by Govt. Photographer.

The usual rate of application is 10 to 12 cwt. per acre. Heavier dressings are often deleterious, as although extra growth may be obtained in the crop, the leaf may not ripen and cure satisfactorily. Usually 10 cwt. per acre is sufficient. The use of the heavier dressing is confined to wet land to compensate for possible leaching from the soil of soluble nutrients.

In most countries it is recommended that the nitrogenous portion of the fertiliser should be supplied as one-third nitrate, one-third as ammonia and one-third from an organic source such as dried blood, fish manures, cotton seed meal, etc. However, in experiments carried out over a number of years at Manjimup, no appreciable increase in yield or quality was obtained from the incorporation of an organic nitrogen fraction in the fertiliser. Experience has shown that any organic nitrogen necessary is best supplied under Western Australian conditions by ensuring that there is sufficient decayed vegetable matter in the soil.

Plate 7

Hydraulic-lift, power driven mouldboard plough suitable for the preparation of tobacco land

—Photo. by Govt. Photographer.

Preparation of the Land for Planting.

After the final ploughing has been done and the land worked to a fine tilth the intended tobacco rows are opened up at intervals of 3 ft. to 3 ft. 6in. The furrows should be about 5 to 6 in. deep and if possible should have a broad flat bottom. Implements in general use are double-board drill ploughs, heavy scufflers with hilling attachments or even ordinary mouldboard and disc ploughs. The fertiliser is applied in the furrow, care being taken to spread it in as broad a

band as possible. The furrow is then filled in. Whatever implement is used, it should if possible, mix the soil with the fertiliser to some extent as well as closing the furrow and leaving a mark to define the planting line. Quite a suitable machine for this purpose is a scuffler with the hilling attachment reversed, a mixing tyne in front of the hillers and a marking tyne behind. Many growers simply use harrows going over the land several times until each furrow is just a slight depression. The plants are set out immediately above the fertiliser band. Although planting is frequently done immediately after manuring, it is advisable to delay planting for a few days in order to obviate possible injury to the roots.

The methods outlined above and the implements described have been in general use in the industry for many years. Recently machines have been developed that will open up, place the fertiliser, close the furrow and mark the planting line in one operation. The rate of fertiliser application is adjustable and uniform. These machines are very satisfactory and constitute a considerable saving in time and labour.

The method in vogue in most countries is to set the plants out on ridges. Except on very wet land, ridging is not practised in Western Australia, as the ridges tend to dry out and the crop becomes drought stricken. Frequently growers only partly fill the furrows so that the plants are set out in a slight depression, the hollow being filled in with subsequent cultivations as the plants grow. This practice ensures a deeper rooted plant, better fitted to withstand shortage of moisture.

Spacing of Plants.

The plants are usually set out from 1½ to 3 ft. apart in the rows. Most growers use a spacing of 18 to 24 inches apart in the row with the rows 3 ft. apart, but others prefer to plant on the square with the plants 3 ft. apart each way to permit of cross cultivation. The latter practice, although minimising labour in cultivation and usually resulting in the production of larger leaves, often produces leaf that is coarse and poor in texture. Very close spacing in the row and particularly when the inter-row spacing is also close, allows insufficient sunlight to penetrate to the lower leaves and the leaf produced is often too thin and papery.

The spacing recommended after extensive trials, is that the rows should be 3 ft. 6in. apart with the plants 2 ft. apart in the row. This inter-row spacing allows for easier cultivation, and permits of passage of the pickers through the rows at harvest time with less damage to the leaf, while the inter-plant spacing allows penetration of sufficient sunlight for maturity and generally results in the optimum combination of yield and quality. The number of plants per acre will vary from about 5,000 to 7,000 according to spacing.

Transplanting.

Practically all transplanting in this State is done by hand. Most land in use for tobacco is not totally cleared and numbers of large dead trees and stumps remain. This militates against the use of mechanical planters and also as the individual areas on which most growers operate are small, the capitalisation is hardly justified.

Plate 8

Hydraulic-lift, power driven, inter-row cultivator drawn behind tractor

—Photo. by Govt. Photographer.

Planting-out over most of the area may be done from mid-October to the end of November, but in coastal districts it might commence a fortnight earlier. Over this period much cloudy weather is usually experienced and frequent showers occur. Transplanting later than the end of November is not advised owing to the possibility of harvest not being able to be completed before the onset of the autumn rains. With planting before mid-October the weather is generally too cold, the plants are slow to commence growing and after stagnating for a while seldom make a high yielding crop.

If possible, the seedlings should be transplanted within a few hours of lifting from the seed-bed. In this respect, the grower who produces his own plants on his farm is in a much better position than one who has to obtain them from elsewhere and it might be up to several days after pulling that the seedlings are transplanted. While some growers make a hole for the plant with a short dibbling stick, most prefer to use their fingers. The most satisfactory way of working, is for one person to drop plants along the rows at the required spacing and the person following to set them in the ground. One dropper can generally feed two rows and keep two planters going. The most convenient way of carrying plants is in a shallow light wooden tray slung at waist level in front of the person dropping, by cords passed over the back of the neck. In planting, the seedlings should

be set well down in the soil and the earth pressed firmly round the roots. Above the roots the earth may be dragged in loosely to general ground level. Under the planting conditions generally experienced, watering is not necessary, but if under warm dry conditions the top soil tends to dry out, a cup of water to each plant when setting out greatly enhances the chances of survival. Under extreme conditions shading each plant with a small strip of paper held in place with clods may be necessary.

Before nightfall on each planting day it is essential that poison bait should be laid around each plant. This is necessary on account of the prevalence of subterranean clover weevil and to a lesser extent cutworms and slugs, all of which are extremely partial to newly planted tobacco. The poison used is a bran-Paris green-molasses bait, which is generally more effective if laid late in the afternoon so that it is fresh when the insects come out to feed at night. The bait should be sprinkled around each plant, but not in contact with it as the Paris green may cause injury.

Where healthy well-grown seedlings have been carefully transplanted there should be little mortality. However, it is advisable to inspect the area within a week of planting and replace dead and weak seedlings. Further inspections may reveal the necessity for further replanting, but if this is done too long after the original setting out the crop will lack uniformity with consequent complications at harvest time. Many growers make a practice of inter-spacing occasional plants when transplanting. When replanting, these plants are lifted with a handfull of earth and used for replacement. Such plants receive no check and make uniform growth with the rest of the crop.

Cutivation.

About 10 days after transplanting, cultivation should be commenced. Inter-row cultivation is done with a horse-drawn scuffler or or suitable powered implement. The soil between and surrounding the plants is broken up with a hand hoe or rake. The first cultivation should not be too deep, so as not to disturb the roots before the plants are properly established.

From this time onward the crop should receive frequent cultivation. Inter-row cultivation should be done as often as possible to keep down weed growth, aerate the soil and conserve the moisture. If such cultivation is done regularly and thoroughly, the labour of hand cultivation may be reduced, but it is desirable that the plants should be hoed at least two or three times. Probably no crop responds more to cultivation than tobacco and its importance cannot be stressed too strongly. Only by keeping the plants growing steadily without check of any kind can high quality leaf be obtained. Competition from weeds or undue loss of moisture from the soil constitute the gravest risks of check to the plants. Cultivation should be continued until the plants reach such a size that the further passage of implements through the crop is likely to cause injury to the leaves.

Plate 9

Hydraulic-lift, power driven, inter-row cultivator in which the cultivator points are distributed along the length of the tractor

—Photo. by Govt. Photographer.

Priming.

When the plants are 9 to 12 in. high, small and damaged leaves at the base of the plant should be removed. This operation is known as priming. If left, these leaves would be of little commercial value. They generally consist of seedling leaves and leaves damaged by insect pests and the fungus disease "Blue Mould." The lowest leaf left should be well clear of the ground. Priming enables the nourishment required by valueless leaves to be diverted to a better quality leaf higher up the plant. The removal of leaves in contact with the soil reduces the possibility of infection with "Blue Mould" and assists to control the disease.

Mechanisation.

Up to the end of World War II there was little mechanisation in the tobacco industry. Since the war however, the high cost and scarcity of labour and the necessity to make the greatest utilisation of the grower's own efforts, has brought about a trend toward the increasing use of power machinery. This has been greatly assisted by the post-war development of tractors with hydraulically lifted, direct-coupled machinery, specially adapted for row-crops.

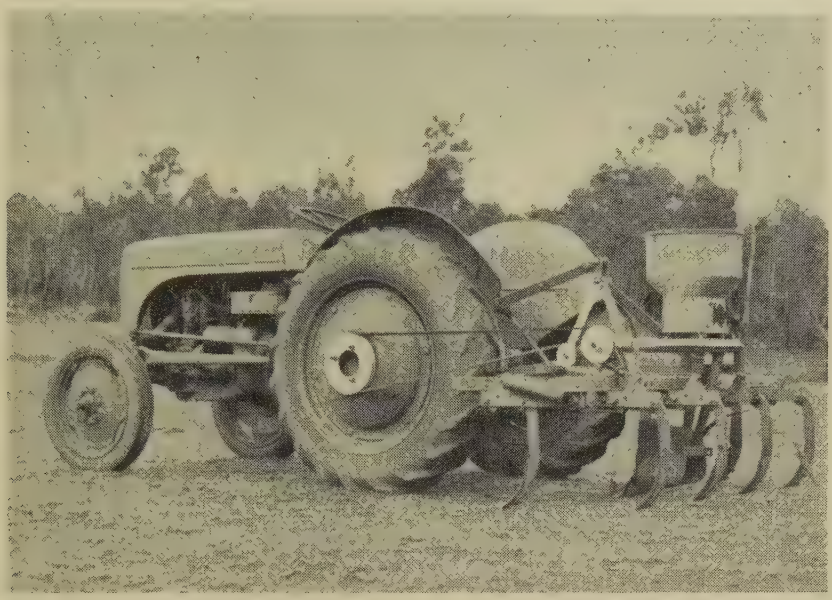

Plate 10

Hydraulic-lift, power driven, fertilising machine which opens up, applies the fertiliser, closes the furrows and marks the planting line in the one operation
—Photo. by A. K. Maley

There are now a number of tractors on the market, each with a series of specially designed implements, which are quickly interchangeable and which offer enormous advantages in speeding up crop operations and very materially reduce labour costs. Implements include both mouldboard and disc ploughs, fertiliser drills which reduce the former operations of opening and closing furrows and applying fertiliser to one and inter-row cultivators. Another advantage these implements possess is that they are fitted with marking devices which enable the even setting out of rows, resulting in more uniform growth and easier crop handling.

While some tobacco crop operations cannot be mechanised the use of machinery on those than can, takes much of the drudgery and tediousness out of the industry. The latest acquisition to mechanised units is a "stringing" machine which has been invented overseas for preparing the leaf for loading into the kiln after it has been harvested. This was formerly a tedious operation having a high labour requirement. Some of these machines are to be introduced to Western Australia and will probably be in use in the near future.

Insect Control.

Until it reaches the flowering stage tobacco is particularly susceptable to damage by insect pests. It has already been stated that immediately after transplanting the seedlings must be protected from the depredations of subterranean clover weevil, cutworms and slugs. The most important of the later pests are leaf-eating caterpillars,

bud-worm and leaf miner. The plants must be protected regularly by spraying or dusting. While spraying is probably more effective, it is more trouble than dusting, and as the latter has been found quite satisfactory in Western Australia it is the method in general use. The dust most extensively used is made by mixing thoroughly 1 lb. of arsenate of lead powder with 15 lb. of pollard. This is applied by shaking a little dust into the growing tip of each plant. A satisfactory form of applicator for practical use is made from a 1 lb. coffee tin or tin of similar type with a slip-on or press-in lid. The tin in the upright position with lid to the top is attached to a stick such as piece of broom handle about 30 in. long. About five or six nail holes are punched in the bottom of the tin and a hole about $\frac{1}{4}$ in. in diameter in the lid. The tin is filled with the dust and the poison applied by giving the tin a sharp shake over the heart of each plant. When accustomed to the operation, the crop can be poisoned by travelling along the rows with the applicator at walking pace. As most insects travel to the growing tip of the plant to feed on the most tender parts, it is only necessary to protect this portion of the plant with poison dust. An occasional hole chewed in the larger leaves, while insects are travelling up the plant is of little consequence, but if the growing tip is damaged, it leads to distortion and suckering instead of the plant growing up on a single stem. Dusting should begin within a fortnight of planting-out and should be continued at intervals of eight to 10 days until the flower buds appear above the topmost leaves.

Plate 11

Poison dusting young tobacco showing the use of applicator described in the text —Photo. by Govt. Photographer.

The poison bait for control of insect pests immediately after transplanting is made by mixing together 1 lb. of Paris green with 40 lb. of bran and moistening with 3 lb. of molasses dissolved in sufficient water to make liquid. When ready for use this bait should be a crumbling mash. If there is a possibility that cutworms, wireworms, subterranean clover weevil or slugs are exceptionally numerous in a piece of land to be planted, their numbers will be greatly reduced by broadcasting this bait over the area a few days before setting out the plants. If slugs are very numerous and the major pest, the most effective control is the use of moistened bran mixed with metaldehyde. Metaldehyde may be obtained from chemists in powdered form or in the form of "Meta Heat Tablets." This substance may also be incorporated in the Paris green—molasses bait. However, it is an expensive poison and is used only when slugs are exceptionally troublesome.

Tobacco leaf miner is seldom of much consequence in Western Australia, although it is a major pest in some other Australian tobacco areas. The only effective means of control is to completely spray the plants at regular intervals with D.D.T.

Grasshoppers can cause considerable damage to a tobacco crop. The circumstances under which this insect generally becomes a pest is when the crop is adjacent to pasture in which the insects are prevalent. While the pasture is green the grasshoppers do not trouble the crop, preferring to feed on the grasses and clovers. However, when the pastures commence to dry out as the summer progresses, the insects flock over and commence feeding on the green tobacco. The insects will not taken poison bait, preferring to feed on the green plants and dusting or spraying is of little value as so much damage is done to the leaf before the insect is killed. Many growers adopt the practice of breeding poultry and running them in the tobacco crop. They do little damage to the crop and destroy large numbers of grasshoppers and other insect pests. Chickens, guinea fowl and young turkeys are particularly effective. On account of the prevalence of foxes in the tobacco districts the poultry has to be locked up at night. Growers generally have a number of portable poultry houses set out in various parts of the crop for this purpose. The poultry are allowed to scavenge through the crop during the day and are just fed a little grain in the houses in the evening to attract them in for locking up. If the grasshoppers are very numerous, unless large numbers of poultry are used, they cannot be controlled in this manner. Under such circumstances the best means of control is to dust thickly a strip of pasture about 10 yards wide all around the crop with Gammexane dust. The insects are poisoned as they pass through the barrier. To be effective the dusting must be done before many of the insects have got into the crop.

Topping and Suckering.

The natural objective of any plant is the formation of seed and large quantities of food materials are built up and stored in the leaves for this purpose. However, tobacco is grown commercially for leaf only and it is desirable that the plant be forced to confine its energy to the production of the maximum quantity of leaf and to conserve the substances stored therein. To do this the flower head is broken off and the operation is known as "topping." It is a general maxim in the tobacco industry that topping improves both yield and quality of leaf.

In most tobacco areas of the world this operation is carried out when the majority of the flower heads have appeared above the top leaves and the earliest are commencing to flower. The simultaneous topping of all plants tends to bring them to maturity together. Topping at the accepted stage was practised in Western Australia until labour became scarce during the war years. Owing to the difficulty of obtaining labour to carry out this operation, growers drifted into the habit of not topping. They found that in addition to saving labour the practice of leaving the flower heads on the plant greatly reduced the formation of suckers and the consequent work of their removal. Some growers actually claimed that they obtained better yield and quality by leaving the flower heads intact.

Plate 12

Crop of variety "Cross Hickory" from which the bottom leaf has been harvested and ready for "topping"

—Photo. by Govt. Photographer.

Extensive experiments, carried out by the Department at its Research Stations over many years, on topping at various stages in the maturity of the crop, have proved conclusively that topping is essential to obtain optimum results. However, the best stage for the removal of the flower heads was found to be later than that previously accepted. It is now recommended that the plants should be topped when the bottom leaf has been harvested, or after the second or third picking. Topping at this stage, not only gives the best results from the yield and quality point of view, but it also practically eliminates the necessity for suckering after topping. One notable exception in which the plant should not be topped is when the crop is grown on

land which is too high in nitrogen, such as land that has been down in pasture containing a preponderance of leguminous species for several years before being broken up for the crop of tobacco. In this instance, the flower head is used to exhaust some the surplus nitrogen and to assist leaf to mature.

Topping at the stage recommended to a large extent eliminates a danger inherent in earlier topping. If heavy rains should fall after topping, it is inclined to make the leaf heavy, coarse and lacking in quality. Removal of the flower heads at the later stage, due to the time factor, greatly reduces the possibility of the crop being affected by rain. In order to leave a "safety valve" in the event of rain, it is advisable to top high and only remove the flower head itself. The small leaves on the top of the plant will absorb excess growth in the event of abnormal conditions occurring.

The actual operation of topping is done by grasping the stem of the flower head firmly in the hand above the point where it is desired to break it off, then the stalk is snapped sharply over the heel of the palm of the hand. At later stages the stems become tough and woody and a knife has to be used for their removal.

From time to time the tobacco plant produces shoots or suckers from the axils of the leaves. If allowed to grow these shoots would flower and produce seed like the terminal shoot at the expense of leaf growth and stored leaf substances. Therefore, they must be suppressed. They should be removed before they exceed three to four inches in length, so that their exhaustive effect on the plant is reduced to a minimum. The first suckers are removed when priming and at regular intervals thereafter. Prior to topping, comparatively few side shoots are produced, but the removal of the flower heads stimulates sucker formation, and their removal becomes a frequent and tedious task. Topping at the stage recommended, which is within a few weeks of completion of harvest, greatly reduces the need for suckering and if the crop matures rapidly after topping, suckering may not be necessary. However if leaf is slow to ripen the removal of side shoots will assist to speed up maturity.

To produce leaf of optimum shape, size and quality, the tobacco plant must be confined to a single stem. Anything that distracts growth from this form must be corrected. For instance, any injury to the apical growing tip of the plant will result in the formation of shoots from two or more axils. If all these shoots are allowed to grow, the leaves they bear will be small, narrow and away from the most desirable type of leaf. In such instances the strongest shoot should be selected to take the place of the apical stem and all other shoots suppressed. The most common cause of failure of the original growing point is insect damage.

Selection of Seed.

Although carefully selected seed is sold by the Department of Agriculture at nominal cost, if the grower has a high yielding, good quality strain of tobacco there is no reason why he should not select his own seed.

Plate 13

Placing the paper bag in position on a selected tobacco seed head which has been pruned to the "crowsfoot" and poison-dusted against insect pests. A second bag is shown tied in position

—Photo. by Govt. Photographer.

The plants to be kept for seed should be carefully selected for quality, yield, size and width of leaf, minimum of suckers and that the upper leaves have width in proportion to length. The seed head is pruned by the removal of side branches until only the "crowsfoot" of the three main branches is left. All open flowers and set pods should be removed. The flower head is then liberally dusted with D.D.T. dust and enclosed in a 14 lb. block-bottomed brown paper bag. The neck of the bag is gathered round the stem of the plant and tied with string. The seed heads should be inspected from time to time for the presence of insects and redusted if necessary. To get the maximum yield of seed, bagging should take place about the time the first flowers start to open. When approximately half the set pods have turned brown, the seed plant may be cut off two or three feet below the head and hung bag downwards in a shed to dry. A reasonable yield of seed from each flower head is ¼ to ½ ounce.

Ley Farming and Lamb Production

Since clover-ley farming has been practised at wheatbelt Agricultural Research Stations in Western Australia, there has been a spectacular increase in the production of high-grade export lambs, from these sources.

Reports submitted by officers of the Wheat Branch of the Department of Agriculture, show in no uncertain manner that the establishment of subterranean clover, wherever the soil types and

rainfall conditions were suitable for its growth, has been followed by an increase in soil fertility and stock-carrying capacity; better crops of cereals with the improvement extending to quality as well as quantity, and a marked decrease in soil losses by water erosion.

At the Chapman Research Station, experimental plantings of subterranean clover have been made with indifferent success for a number of years but it was not until about 1943 that the impact of improved pasture establishment techniques began to make itself felt. In that year, 358 lambs were treated of which 50 per cent. achieved first-grade classification. By 1948, the station's lamb crop was 404 head, of which 30 per cent. were classed as Swandown or super-grade, with a further 61 per cent. attaining the first-grade quality. The 1950 gradings for 439 lambs were Swandown 24.5 per cent. and first-grade 70.9, which meant that 95.4 of the lambs submitted reached the two top classifications. Of 422 lambs graded this season to date, over 97 per cent. were graded either Swandown or first-grade with about 24 per cent. in the higher category.

At the Avondale Research Station, near Beverley, subterranean clover pastures have brought similar results. In the current season, the 400 lambs treated to date have averaged 38.5 lb. carcass weight per head and graded out with 97.75 per cent. first-grade and better. Almost a third of these achieved the coveted Swandown classification.

In addition to rearing these excellent lambs the station ewes averaged 12.4 lb. of wool per head in the case of 705 Border Leicester-Merino crossbreds, and 11.4 lb. per head for 213 Merino ewes. The lambing percentage at the station was 94 per cent.

LIGHT LAND SUCCESSES

On the low-fertility light lands upon which the Wongan Hills Research Station was established, the transformation wrought by ley-farming has been little short of miraculous. Prior to the general establishment of clover on these soils, the percentage of lambs reaching the two highest gradings were from 2.4 to 29.1 of the total marketed. With the advent of clover pastures the proportion of first-grade lambs rose steeply to 52 per cent. in 1946 and was around 87 per cent. in 1948-49-50. Of 85 lambs killed to date in the current season, 75 have been first-grade.

The advantages of ley-farming are indirect, as far as lamb production is concerned. Lambs eat very little clover as they are reared during the winter period when the clover is green and unpalatable to stock but the dry clover provides a wealth of protein-rich fodder for the pregnant ewes during the summer months when other pastures are low in nutritive values. Fortified by good summer pasture, the ewes are able to derive the maximum benefits from cereals such as oats sown as cover-crops in the initial clover plantings or scratched in on the older stands. The copious milk-flow induced by early green feed gives the lambs a good start in life and they reach marketable weights with a minimum of delay.

Reproductive Efficiency of the Dairy Cow

Some Figures from the U.S.A.

L. C. SNOOK, Animal Nutrition Officer.

Infertility among dairy cows has at times caused heavy losses to farmers in Western Australia. The statement is often made that dairy cow infertility is a world wide problem. This may be scant consolation to the local man with an affected herd but it is not without interest to study the severity of this problem overseas.

An enlightening summary is given in an American journal (*J. Dairy Science,* 34, 495, 1951) of a survey made by H. P. Davis, a worker at the University of Nebraska, U.S.A. He has analysed the breeding records of the pedigree Holstein herd kept by the University since 1897. The herd has been well-managed, well-fed and appears healthy. Contagious abortion was eliminated in 1934.

The production figures have steadily improved. Using the American standard lactation period of 305 days and correcting all returns to a mature cow basis, the herd has averaged more than 1,300 gallons of milk and 500 lb. of butterfat per lactation over the last 10 years. This makes an analysis of the reproductive history all the more valuable.

First of all, Davis has listed the number of services required for each conception. As expected, heifers proved most difficult to get in calf, requiring an average of almost three services per calf born. To obtain the fourth calf an average of only two services was required. Over all, $2\frac{1}{2}$ services were required for each successful conception. This proportion of services is similar to that reported from Britain and New Zealand.

On the assumption that five services per cow is the greatest number which can be tolerated by a practical dairy farmer, Davis worked out the percentage of cows which conceived after five services or less. Here again the heifers were least efficient, only 86 per cent. falling in this class whereas after the third calf, 96 per cent. of the cows conceived under the same conditions. Considering all cows, nine per cent. required more than five services. This indicates the seriousness of the infertility problem to the dairy farmer. When repeated services are necessary the farmer cannot possibly plan ahead. He has to start mating his cows too soon after calving just to make sure that some at least will calve down at the desired time in the succeeding year. As a result the cows keep coming in over many months and the farmer can never get the desired clean break of a month or so during which no cows require milking.

Another interesting point brought out by Davis is the over-long interval between calves. In this pedigree herd the heifers come into milk at the average age of 2½ years. Between the first and second calf there is an average interval of 452 days, or almost 15 months. This interval between calves is general for cows of all ages and expresses in another way the poor reproductive powers of the heavy-milking dairy cow. From my knowledge of the problem in this State I should say that there are few pedigree herds where the reproductive rate is better than that reported from Nebraska. Certainly in some of the high-producing herds supplying whole milk to the metropolis, the long interval between calves would appal even the owners if the figures were worked out.

In the Nebraska herd under review it was found over the years that only 46 per cent. of the calves born were heifers. With a calving interval of 15 months this meant that each 100 cows produced only 36 heifer calves each year. When one makes allowance for losses due to accident and disease and for a certain amount of culling of poor producers, it becomes apparent why so few good cows can be sold by the average stud-breeder. Many owners must find it difficult to maintain their herds at full strength, although culling of females is reduced to a minimum.

Comprehensive studies are being made by research teams throughout the world in an endeavour to reduce the serious wastage in dairy herds which results from poor breeding efficiency. In Western Australia we also have begun controlled experimental work at the Bramley Research Station. It is obvious from Mr. Davis's researches how urgent is the need for an understanding of the problem.

Storage of Stone Fruit

F. MELVILLE, Acting Assistant Superintendent of Horticulture
S. E. HARDISTY, Horticultural Adviser

During the past three seasons, research work into the cool storage of stone fruit has been carried out by Messrs. T. C. Miller, S. E. Hardisty and F. Melville, of the Horticultural Branch of the Department of Agriculture, in this State. As the Singapore market —which absorbs from 5,000 to 7,000 bushels of stone fruit, mainly plums, each year— is the most promising overseas market, it was necessary to take into consideration the conditions which are applicable to this trade.

At the present time the individual shipments are small and do not warrant the maintenance of cooling chambers at special temperatures on shipboard with the result that the main factors within the exporters' control are:—(a) the stage of maturity at picking; (b) the pre-storage conditions; and (c) the storage conditions prior to shipment.

The cool storage work which has been in progress over the past three seasons has been based on these factors. During the 1949 season Santa Rosa and Narrabeen plums were used. These were followed by Ruby Blood plums in 1950, while in 1951, the investigations included Santa Rosa and Narrabeen plums and Elberta peaches.

The earlier work was carried out in ordinary commercial chambers where the experimental fruit was mixed with commercial lines and storage conditions were very variable. During the past season special small rooms were used, but even in these it was extremely difficult to maintain reasonably constant temperatures.

PLUMS

(a) Santa Rosa.

In 1949 Santa Rosa plums were picked at three stages of maturity based on the colour of the fruit. For this variety the development of the red colour is a very useful guide to maturity. The fruit was packed in trays, portion was stored immediately at 32°F. while other portions were given pre-conditioning treatments of two and four days respectively at 65°F. (approximately) before storage at 32°F. Inspections were made at intervals as the fruit was removed from store, but, unfortunately, no details were kept of the ensuing ripening period. The true life of the plums could not therefore be assessed.

Fruit picked while still hard and green with only very slight development of colour, juice, or flavour failed to ripen satisfactorily. Pitting was common together with a condition attributed to cold injury. Plums harvested when one-third coloured, ripened much more satisfactorily. Colour, juice content and flavour were quite good on removal from store.

In the third group, containing fruit two-thirds coloured, the plums after storage were softer with some wilting and generally thought to be slightly inferior to the previous group. Pre-conditioning at 65°F. for periods of two and four days respectively, was no improvement over immediate storage due to the increased wilting and undue softening which resulted.

Under the conditions of the experiment the apparent life in store varied considerably between groups and between treatments, but appeared to be between 25 and 39 days. It seems probable in light of further work that much of this fruit may have been overstored at 32°F.

Information gained in this initial research work plus a wealth of data from other sources was used in the planning of the 1951 experimental programme. It had been suggested by the C.S.I.R.O. Laboratories, Homesbush, that harvesting at a more mature stage, followed by immediate storage at 30°F. should give good results. This method therefore formed the basis of the recent experiments, but in addition a further treatment was tested in which the fruit was stored at 30°F. for two weeks, followed by a period of storage at 45°F.

Three groups slightly more forward than in the 1949 season were selected and stored the same day at 30°F. Half-dumps were used in preference to trays, as this is the usual pack for export.

At the end of two weeks an initial inspection was made prior to removing half the fruit to 45°F. It was found at this stage that a large proportion of the fruit amounting to between 80% and 90% in some cases had developed an internal browning around the stone. Constant temperatures were very difficult to maintain and it is known that at one stage the temperature dropped to 29°F. and below for several days. The damage was considered to be due to this low temperature. Some evidence of internal browning had been seen in 1949, but was not serious.

Although the development of this disorder prevented detailed results of the storage life of the plums being determined, it nevertheless did not lead to a general breakdown of the fruit and many of the ripening characteristics such as colour, juice development and softening could be studied. As originally planned one portion of the fruit was transferred at the end of two weeks to 45°F. while in the other chamber the temperature was raised to 32°F.

Inspections were made at regular intervals of plums ex store and again five days later. It was found that little change occurred in colour until the fruit was removed from store. The colouring was particularly uniform in individual cases. The most notable feature was that plums picked on the green side failed to ripen satisfactorily. It appeared that plums should be at least three-quarters coloured at picking to ripen properly. Under these conditions the fruit was stored satisfactorily for up to six weeks.

In the case of the dual temperature storage less mature plums ripened more readily than at the lower temperature, while plums fully red at picking were over-ripe after six weeks storage under these conditions.

(b) Narrabeen.

In 1949 three groups of plums varying in maturity from hard green, to firm and two-thirds coloured were stored in trays in commercial rooms. Some were stored at 32°F. immediately while others were given a two and four days pre-conditioning period at 65°F. prior to storage.

An inspection in cool store after 15 days indicated that little change had occurred except that the pre-conditioned fruit was slightly more advanced and softer. At the end of 26 days all fruits were showing signs of ripening and some wilting was evident. The fruit was allowed to ripen out of store for four days at the end of which time it was found that only plums in the more mature groups at picking had ripened properly. Pre-conditioning was only of benefit in the less mature group.

The work was continued in 1951 when plums of two degrees of maturity were selected. The plums were picked at weekly intervals and packed in half-bushel cases. One lot was stored at 32°F. and a second lot at 32°F. for 14 days followed by 45°F. Inspections were made out of store and four days later.

Examination of the plums in the 32°F. treatment showed that fruit picked when well-coloured and with a yellow-green ground colour stored the best. At the end of two weeks these plums showed only slight increase in colour and when ripened out of store were juicy with good flavour. A slight increase in colour occurred with a further fortnight in the store, while after four days out of store the condition of the fruit was very good with full flavour and juice, although the fruits were slightly soft. After a period of six weeks in store the fruit was over-ripe.

Fruit picked one week earlier which was firm with a light green ground colour and slight blush was firmer when removed from store but did not ripen as well as the previous group. At the end of a four-week period in cool store, the fruit had ripened slightly, but after four days at room temperature, although the flavour and juice had developed, the characteristic colour was still lacking. At this inspection and at the subsequent inspection made after a total storage period of six weeks some of the fruits were bladdery and some showed internal browning. After six weeks in the cold store the fruit generally was juiceless with little flavour with some shrivelling.

The fruit which had been stored at 45°F. after two weeks initial storage at 32°F., became highly coloured and soft. Fruit of the early maturity after storage for two weeks at 45°F., and ripening for four days out of store, became very soft and shrivelled. The flavour was fair. A further fortnight's storage at 45°F. produced over-ripe fruit. Fruit in the more mature group was found to be over-ripe after two weeks at this temperature.

As with Santa Rosa plums it was apparent that the fruit should not be picked when immature. On the other hand, the dual temperature storage showed no improvement over storage at a low temperature, due to undue softening when removed to the high temperatures prevailing out of store.

(c) Ruby Blood.

During the 1950 season the storage investigations were extended to Ruby Blood plums. The picking maturity is difficult to judge in this variety, but an endeavour was made to select three groups ranging from immature fruit to fruit which had developed the characteristic deep red colour, juice and flavour of the variety. The plums were packed in trays and divided into three treatments, namely, immediate storage and pre-conditioning, at 55°F. for one and two days. Unfortunately, at the end of three and a half weeks, it was necessary to remove the fruit to one of the general cool store chambers where various kinds of fruit were being stored and where the temperature at times rose well above the desired limit. This no doubt shortened the life of the fruit. Inspections were made at intervals, firstly as the fruit was removed from store, and secondly after three days at room temperature which varied between 75°F. and 80°F. maximum.

Plums picked when hard, 50% coloured and with little juice development, failed to ripen satisfactorily when exposed to atmospheric temperatures following a storage period of 15 to 30 days at 33°F. Pre-conditioning for 1-2 days improved the final condition of the fruit when storage did not exceed three weeks.

Fruit which was full red, more juicy and generally more mature, ripened very successfully after 24 days at 33°F. When stored longer, the plums were soft and over-ripe. Pre-conditioning in this group resulted in soft and over-ripe fruit. Even after 14 days at 33°F. the pre-conditioned plums were ripe when removed.

A third group of plums picked 16 days later than the previous lots contained deep red, firm and juicy fruit. Inspection of this fruit after 16 days showed that in all treatments it was over-ripe. The maximum storage period was apparently much less than this. Storage of Ruby Blood plums as ripe as these appears impracticable.

PEACHES

Elberta peaches at two stages of maturity were stored during the 1951 season, portion at 32°F. and portion at 45°F. Inspections were made of the fruit out of store at regular intervals and again after four days at atmospheric temperatures.

Peaches which, at picking, were hard and green with slight development of blush, but with little change in the ground colour when stored at 32°F., were found after two weeks to have undergone little change. At the end of four weeks the fruit ripened fairly well out of store, but was slightly lacking in juice. After six weeks in store the fruit was of good appearance when ripened, but the flesh was dry and mealy.

Where peaches slightly more advanced in colour than the previous group, with some yellowing of the ground colour, but still firm, were stored, the results in all cases were better. Colour, juice content, texture and flavour were improved, but after five weeks in cool store, the fruit softened considerably when removed to outside temperatures.

One section of the fruit after storage at 45°F. for two weeks was transferred to 32°F. However, under these conditions all fruit had ripened excessively at the end of four weeks and an off flavour had developed.

GENERAL

There is no ready means of determining when stone fruit has reached the end of its storage life while the fruit is still in store. This means that fruit which appears satisfactory in store may not ripen successfully when removed. The storage life which is the maximum time fruit may be stored and still ripen properly must therefore be based on past experience.

The maturity of the fruit at picking is closely connected with the storage life as has been indicated in the foregoing sections. Immature fruit will never ripen satisfactorily although it may appear to retain its condition in store for long periods. On the other hand over-maturity may result in various symptoms typical of over-ripeness appearing in fruit when removed from store.

Generally speaking it would appear that for all the varieties used, harvesting at a stage when the fruit is showing definite signs of ripening, followed by immediate storage at a temperature in the vicinity of 32°F. will give the best results when the fruit is to be ripened under high temperature conditions after removal from store.

ACKNOWLEDGMENTS

The writer wishes to place on record his appreciation of the generous measure of assistance and general co-operation received from the Western Australian Fruit Growers' Association, and from Messrs, R. C. Owen of Carmel, S. E. Ward of Kelmscott, B. V. Cross and Sons of Bedfordale, and D. G. Watkins of Jarrahdale, in the conducting of the storage experiments.

SUMMARY

1. Santa Rosa plums stored best when picked with three-quarters to full red colour. It seemed likely that storage up to six weeks would be satisfactory. Low temperatures or excessive periods at 32°F. or lower are likely to produce internal browning.

2. Narrabeen plums stored well when picked at a stage when the ground colour had developed a definite yellow green colour. At this stage the fruit had commenced to soften and was from half to full coloured. Storage was satisfactory up to four weeks.

3. The storage of Ruby Blood plums was most successful when the fruit was picked when full red, after juice and flavour had developed, but while the plums were still very firm. Long storage of this variety is unsatisfactory and three weeks was the safe limit under the conditions of the experiment.

4. With Elberta peaches, fruit at picking should have developed a definite change in the ground colour without undue softening to ensure satisfactory ripening out of store. The peaches failed to ripen satisfactorily when stored much in excess of four weeks.

5. Pre-conditioning of plums appears to be of little value for fruit forwarded to a climate such as is found in Singapore, where a ripening temperature in the vicinity of 80°F. is experienced. By the same token dual temperature storage is also of less advantage than for fruit going to cold climates.

Bulk-Handling of Superphosphate

Experiments at Cunderdin

D. S. HORWOOD, Fertiliser Rationing Officer.

In these days when jute supplies are increasingly jittery and bag costs soar to dizzy heights, West Australian farmers have good cause to bless the day when this State pioneered on unorthodox but highly successful methods of bulk-handling its grain crops. Recent experiments at Cunderdin suggest that similar methods of handling superphosphate in bulk may further extend the savings in bags.

On October 11th some Cunderdin farmers, with representatives from Cooperative Bulk Handling Ltd., superphosphate manufacturing firms, the local governing body, the Farmers' Union of W.A., the Department of Agriculture and the W.A.G.R. collaborated in the experimental handling of 60 tons of bulk superphosphate from five railway trucks to motor vehicles. The methods tried were:—

1. Manual shovelling into a bagging hopper attached to the railway truck from which it was bagged direct on to the farm truck. By this method two men handled a ton of superphosphate in 7½ minutes.

2. A Clark mechanical shovel fed the bulk superphosphate into an elevator which took it to a bagging hopper over the farm truck where it was bagged and loaded. Four men handled 5 tons of superphosphate in 11½ minutes.

3. The mechanical shovel fed the superphosphate into an elevator and direct to farm truck fitted to carry the load in bulk. Three men handled 4 tons 14 cwt. in 9½ minutes.

Various combinations of these methods were used, also superphosphate was unloaded from rail trucks by mechanical shovel and elevator into the wheat bins from which it was discharged into bulk farm trucks or to baggers.

A remarkable feature of the trials was the almost negligible amount of dust and wastage, even though the machinery used was to all intents and purposes that normally used for handling wheat.

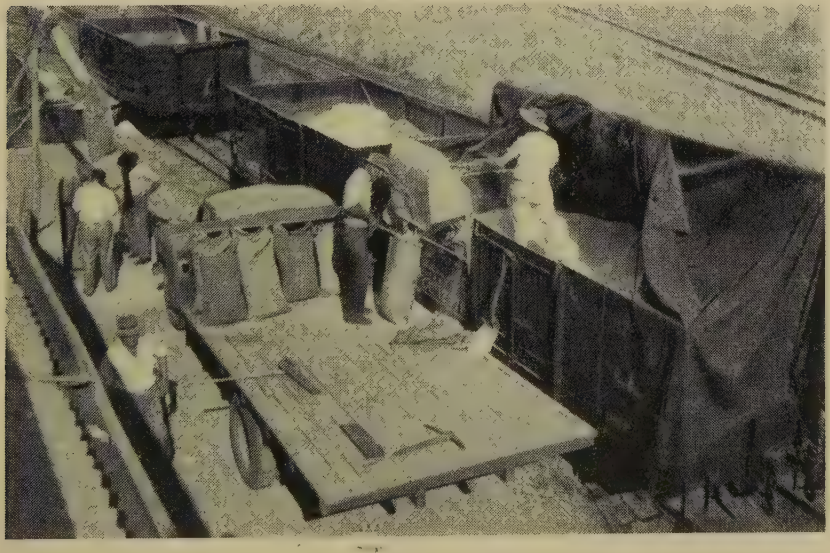

Fig. 1.

Bagging superphosphate by manual shovelling into a special bagging hopper hooked to the side of the railway truck.

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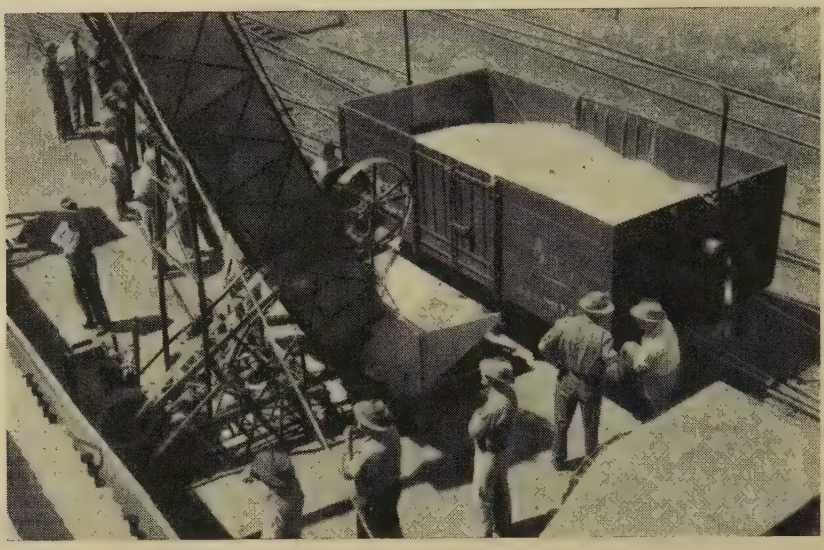


Fig 2.

Bulk truck of superphosphate about to be discharged into modified Cooperative Bulk Handling Ltd. elevator for transfer either to the wheat storage bin or to farm trucks.

Modifications to the mechanical shovel and to the hoppers and elevators to adapt them for this specific job will present no major engineering difficulty and will save spillage and labour. No doubt as time goes on other improvements will suggest themselves.

The weather is a most important factor, and wet conditions could make for difficulties which may take a deal of ingenuity to overcome. At the moment there is no obvious solution, other than the provision of a shed covering a railway spur, but engineers have overcome greater difficulties and can doubtless be relied on to meet this situation.

Handling on the farm will present certain difficulties and to take full advantage of the bulk-handling facilities, farmers would need trucks equipped with steel tipping bodies, and sufficient covered, concrete-floored storage space on the farms to hold their superphosphate requirements for reasonable periods. However, the initiative of the farmers themselves will doubtless enable them to overcome minor obstacles, and already mechanical devices are being made to assist in this direction.

Undoubtedly the Cunderdin experiments showed that free running superphosphate can be handled satisfactorily with the existing grain-handling equipment. The trials mark the passing of another milestone in agricultural progress and provide further proof that co-operation and self-help can overcome many of the difficulties arising in this changing world.

Fig. 3.

Superphosphate being discharged into the bin from a modified C.B.H. elevator. The pile in the background is superphosphate stored from a previous experiment.

Fig. 4.

Discharging superphosphate from the rail truck on left into a C.B.H. elevator and thence into a bagging hopper situated on the farm motor-truck.

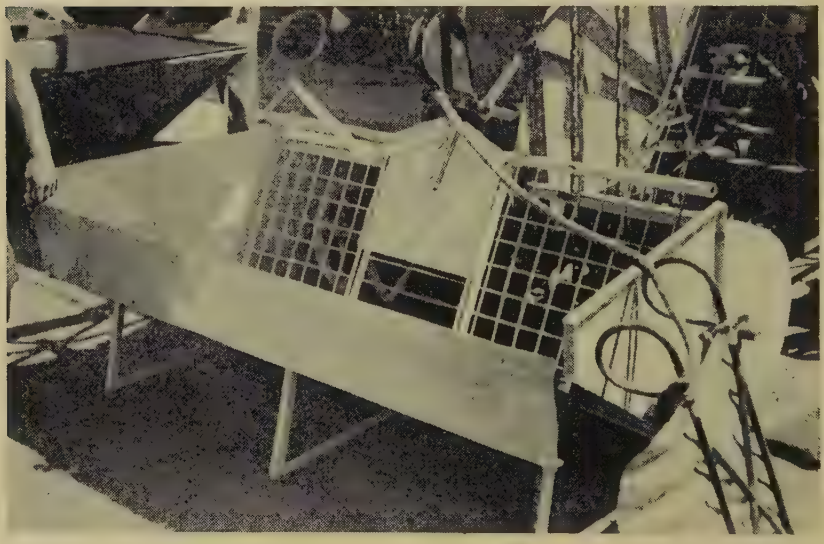


Fig. 5.

The modified boot, hopper, gate and screws fitted to the standard C.B.H. grain elevator to assist in handling bulk superphosphate.

STOCK FOODS

ADDITIONAL STOCK FOODS WHICH HAVE BEEN REGISTERED AT THE DEPARTMENT OF AGRICULTURE UNDER THE FEEDING STUFFS ACT, 1928-48, FOR THE YEAR COMMENCING 1st JULY, 1951.

Stock Food.	Reg. No.	Brand.	By whom Registered.	Materials from which Made.	Registered Analysis.							
					Crude Protein.	Crude Fat.	Crude Fibre.	Sodium Chloride.	Phos. Acid (P_2O_5).	Calcium (Ca).	Other.	
					% (Min.)	% (Max.)	% (Max.)	% (Max.)	% (Max.)	% (Max.)		
A.—SIMPLE FOODS.												
1.—Meat Meals.												
Meat Meal	143	WRIGHTS	Wrights, Limited	Animal waste	40·0	10·0	1·5	1·5	18·0	15·2	....	....
2.—Meat and Bone Meals.												
Meat Meal and Bone Meal	135	EXCELSIOR....	Barrow, Linton & Co.	Meat and bone	38·0	15·0	1·5	....	....	....	....	....
Bone and Meat Meal	142	KITCHEN'S	J. Kitchen & Sons Pty., Ltd.	Animal fat and bone	40·0	10·0	1·5	1·5	18·0	15·2	....	....
Fortified Protein Meal	144	IMPERIAL	W. Angliss & Co. (Aust.) Pty., Ltd.	Meat and bones	50·0	14·0	2·0	....	....	....	....	....
4.—Liver Meals.												
Liver Meal	145	IMPERIAL	do. do. do.	Meat, bones and liver	65·0	22·0	....	....	....	....	....	....
B.—COMPOUND FOODS.												
1.—Protein Meals.												
Protein Concentrate	136	EGGOLEEN	Barrow, Linton & Co.	Meat meal, cereals, and mineral	37·3	12·0	1·5	....	....	....	....	....
5.—Poultry Foods.												
Growing Mash	137	GROWELL	do. do. do.	Bran, pollard, wheat meal, meat meal, riboflavin, fish oil, bone meal, shellgrit, salt	15·0	*3·5	5·0	1·0	....	*3·5	....	....
Laying Mash	138	EGGLAYER	do. do. do.	Bran, pollard, wheat meal, meat meal, bone meal, shellgrit, salt	15·0	*3·5	5·0	1·0	....	3·5	....	....
Fattening Mash	139	DUKKO	do. do. do.	Bran, pollard, meat meal, bone meal, salt	15·0	5·0 *4·0	5·0	1·0	5·0	5·0	....	....
6.—Chick Foods.												
Chick Starter	140	VITALIZER	do. do. do.	Bran, pollard, meat meal, wheat meal, bone meal, shellgrit, salt, riboflavin, emulsified fish oil	16·0	3·9 *3·5	5·0	1·0	....	*3·5	....	....
Grain Food	141	CHIC CHIC	do. do. do.	Wheat, oats, maize, peas	9·0	*2·27	5·0	....	....	....	....	....

* Minimum.

"Pilot" Poultry Farms

R. H. MORRIS, Officer in Charge, Poultry Branch.

An interesting series of practical experiments in poultry farming will commence in December, 1951, when, by arrangement with the owners, the Poultry Branch of the W.A. Department of Agriculture will direct operations on six commercial poultry farms in this State. For the period of the experiment which is expected to last about two years, the farms will be visited frequently by officers of the Poultry Branch and will be operated entirely in accordance with their recommendations.

These recommendations are based on the latest Australian and overseas research and it is anticipated that the progress made on these "pilot farms" will provide concrete examples of the efficiency of the methods advocated by the Department.

SUCCESS STORY

The genesis of the idea goes back to 1949, when a young War Service Land Settlement poultry farmer sought the advice of the Department of Agriculture concerning a serious infectious laryngo-tracheitis epidemic on his property. After an inspection, the officers of the Poultry Branch advised the sale for slaughter of the entire flock of 1,000 hens and 1,100 pullets and the resting of the property for three months prior to re-stocking.

The owner expressed his willingness to act upon the advice and in due course the property was re-stocked with 1,250 day-old chicks which were managed entirely according to the recommendations of the Poultry Branch. As a result of this, the farm attained a particularly high average of production and today this farmer has overcome all his initial setbacks and is soundly established on a profitable basis with a model property and a high-producing, healthy flock.

SCHEME EXTENDED

This man's success prompted an extension of the scheme and the Department has received a number of applications from other poultry farmers willing to co-operate with the branch on similar lines. Five other farms will now be managed by their owners who will be expected to follow meticulously the programme drawn up by the Poultry Branch. The flocks on these farms will include White Leghorn, Australorp and First Cross birds, and housing will range from intensive to semi-intensive lay-outs.

Some of the main management points to be emphasised will be the use of chicks hatched at the right time of the year and their correct brooding and feeding. Chicks will be introduced to perching platforms at five weeks with a view to having them fully perching at nine weeks. They will be de-wormed at ten and 18 weeks and vaccinated against fowl-pox at 12 weeks.

Dry mash given per medium of self-feeders will be the basis of the feeding arrangements on all farms, and rations fed on the farms will be mixed by one firm according to the Department's formula.

Main feature of all mashes will be the maintenance of adequate protein and mineral levels and the regular use of fish oils to guard against vitamin A deficiencies.

The use of deep litter and the lighting of laying sheds to lengthen the day to 15 to 16 hours in the autumn and early winter will be standard procedure, and most of the farms will adopt the community-type nest with white sawdust as these methods have been shown to reduce the proportion of broken and dirty eggs.

The keeping of careful records will be an essential feature of the scheme and it is expected that the results obtained on the pilot farms will provide adequate proof of the soundness of the methods advocated and lead to their wider adoption by poultry farmers in this State.

Automatic Windmill Shut-off

An Ingenious Device Which is Popular in the North-West

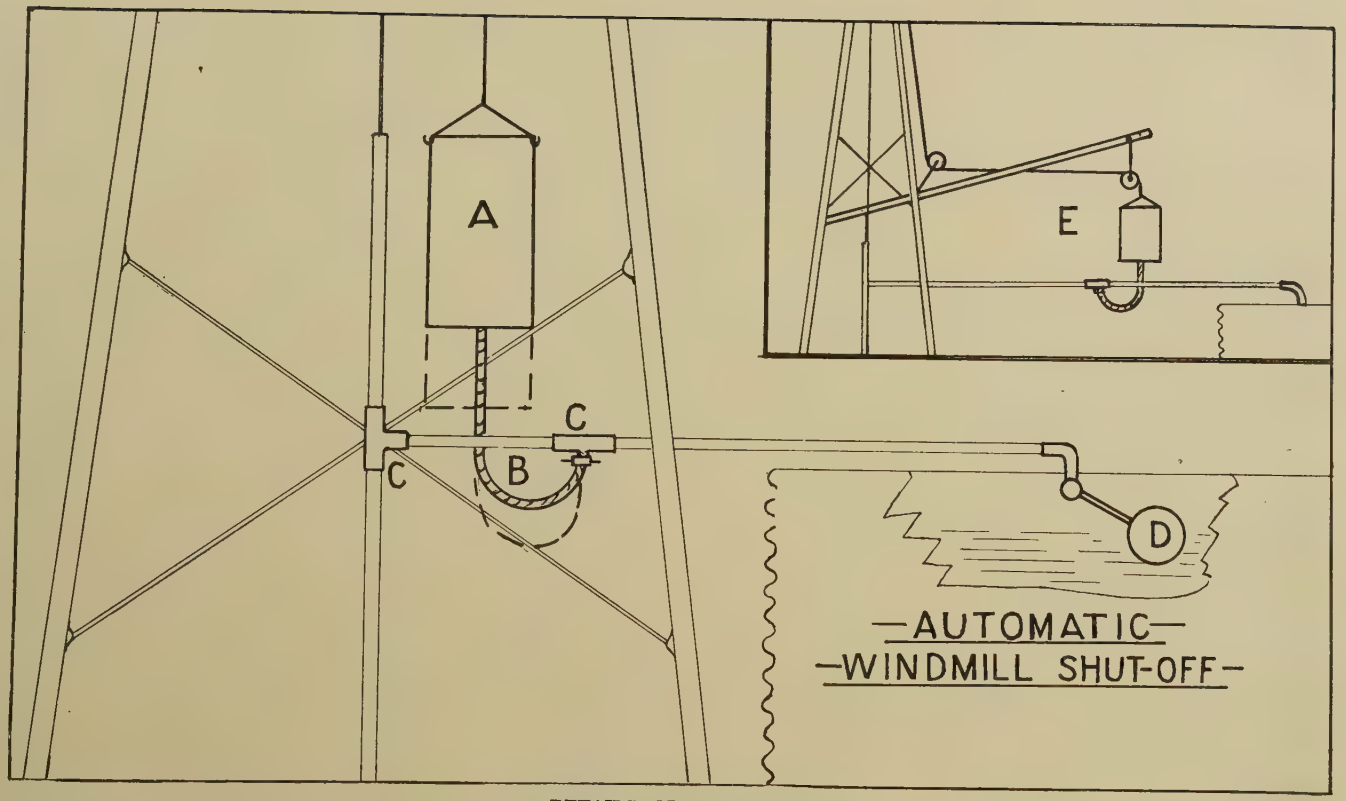
H. K. GIBSONE, Officer in Charge Irrigation

Throughout the North-West station country where much depends upon the efficient working of large numbers of windmills operating far from the homesteads and outcamps, one encounters a wide variety of ingenious gadgets designed to ensure that unattended mills are turned out of the wind when the storage tanks are filled. The device described here is fitted to many of the mills on Abydos Station in the Port Hedland district, and while it may be "old stuff" to Nor'-West readers it may provide a simple solution to one of the problems encountered by windmill users in the southern portions of the State.

Station men have assured me that it is one of the best automatic shut-off ideas of the many now in use. Among other advantages, the pump is always kept wet and fully primed, making for long life of the pump leathers. It is positive in action, in that the mill is either shut off or fully on, which is a distinct advantage where mills are fitted with brakes. The tank is always full, as a drop of even two inches in the level of the water within the tank will bring the mill back into the wind immediately. Some popular shut-off devices, which are operated by floats in the tank, do not bring the mill fully into action until the water level has dropped a foot or more, and a foot of water in a large tank represents a considerable gallonage.

DETAILS OF CONSTRUCTION

A five-gallon drum has a hole cut in the bottom to take a short length of metal piping secured either by soldering or by means of washers and back-nuts. Two or three inches of piping should protrude below the bottom of the drum, sufficient to provide a firm attachment for a length of rubber hose. The length and diameter of the hose will



DETAILS OF DIAGRAM

(a) Five-gallon drum hung on shut-off wire. (b) Length of rubber hose. (c) T-piece. (d) Ball-valve. (e) Method of rigging a spar for narrow-based mill towers.

be dependent upon the size of the mill and upon the piping available, but a two-foot length of one-inch or three-quarter inch hose will suit most mills. One end of the hose is securely clamped or wired to the piping and the other end is similarly attached to a T-joint inserted in the pipe running from the mill to the tank. The drum, which is fitted with a handle, is then suspended from the shut-off wire of the mill at a height which ensures that the bottom of the drum is a few inches above the outlet pipe when the mill is shut off. A ball valve is fitted to the end of the outlet pipe in the tank and you have a sturdy automatic mill shut-off which will operate year in and year out with a minimum of attention.

OPERATION

The principle is that when the tank level is low, the ball valve is open and the water runs into the tank without hindrance. As soon as the level has risen sufficiently to bring the ball valve into operation closing the outlet pipe, the water is pumped into the drum per medium of the rubber hose and its weight is sufficient to pull the shut-off wire and "furl" the mill. A slight lowering of the water level in the tank causes the ball valve to open again, permitting the water to drain out of the drum. The empty drum is too light to operate the shut-off wire and the mill swings back into the wind.

The drum should be tarred or painted both inside and out to delay the action of rust, as obviously it cannot operate efficiently if it is holed.

Where the spread of the tower-legs is too narrow to permit the drum to hang within the tower, a spar may be attached to the tower legs to carry the drum outside the framework. In that case a length of flexible wire rope attached to the shut-off wire may be used in conjunction with pulley-blocks to alter the direction of the pull, as indicated in the small inset diagram.

Water running down the side of an over-filled tank as the result of wave action caused by wind

DO NOT OVER-FILL THE TANK

When fitting a ball-valve as in this case, or when fitting any other kind of automatic shut-off, always adjust so that the tank can never fill right up to the brim. The high-water mark should be a few inches below the top rim of the tank, the actual distance being governed by the tank diameter.

If a large tank is permitted to fill to within a short distance of the top, even a mild breeze will set up sufficient wave action to cause water to flow over the top rim almost continuously. Apart from the wastage of water, this may cause the mill to be constantly brought in and out of action for short periods and furthermore, the action of the water may undermine the tank foundations or lead to eroded gullies in the earth near the tank.

Phosphorus Supplements for Dairy Cows

L. C. SNOOK, Animal Nutrition Officer.

TO ensure continued high milk production and good health it is essential that dairy cows should receive adequate supplies of phosphorus in their food. For many months of the year typical West Australian pastures do not contain sufficient of this essential phosphorus. If the farmer fails to provide the correct form of mineral supplement the cows cease to produce milk to full capacity, or they deplete their bodily reserves with resultant ill-health. In either case the farmer suffers financial loss.

Before the war the need by the dairy cow for additional phosphorus received continual emphasis, and the provision of phosphatic licks was accepted as part of good farming practice. But during 1940-46 the feeding of bonemeal and di-calcic phosphate went right out of fashion, firstly because these materials could not be purchased, and subsequently because there was no obvious evidence that the cows suffered when these licks were withdrawn. Farmers are also topdressing their pastures with increasingly heavy annual applications of superphosphate, and it is not surprising that the resultant high quality mixed pastures should be expected to contain all the phosphorus needed by dairy cows. Such is not the case, however.

Recent studies have shown very clearly that many cows in our South-Western dairying districts are suffering from a real or incipient phosphorus deficiency. This must certainly affect milk production, and may also reduce resistance to disease and be one explanation of seasonal sterility. It seems that good milking cows while on winter pastures cannot make good the losses in phosphate suffered during the summer, when dry feed relatively deficient in phosphorus forms the bulk of the diet. It is well known, of course, that, as pasture plants

mature, the phosphorus content falls, but very few realise just how serious this fall can be to the milking cow. Even good quality meadow hay cut from excellent South-West mixed pastures does not contain enough phosphorus. The present indications are that not only should dairy stock of *all types* receive phosphatic supplements during the summer months but that supplements should be fed to milking cows during the winter as well, as it is during this time that lactation imposes the maximum drain on the mineral reserves.

PHOSPHATIC SUPPLEMENTS.—COST PER UNIT OF PHOSPHORUS, RETAIL PRICES, PERTH, OCTOBER, 1951.

Material.	Purchase Price.	Cost per 100lb.	Phosphorus Content (per cent. P).	Cost per Unit of Phosphorus.
		£ s. d.		
Superphosphate	£14 10s. 6d. per ton	0 13 0	8 (water soluble)	20d.
Bonemeal	15s. 9d. per 70lb. bag	1 2 6	12 (total)	22d.
Boneflour	£2 per 140lb. bag	1 8 7	14 (total)	25d.
Di-calcic Phosphate	£65 5s. per ton	3 2 0	16 (total)	46d.
Ground Rock Phosphate	£13 10s. 11d. per ton	0 12 1	17 (total)	8½d.

POSSIBLE PHOSPHATIC SUPPLEMENTS

Bonemeal.

Sterilised bonemeal has for many years been the standard source of phosphorus for use in stock foods and mineral licks. Bonemeal is an excellent supplement in that it supplies not only phosphorus but presumably all the other essential minerals which have been used to build sound healthy bone.

Bonemeal is commonly made available to stock mixed with an equal weight of common salt. The mixture can be placed in boxes set up in convenient places in the paddocks. Some sort of shelter to keep out the rain is necessary. This method of supply has a number of disadvantages, however. Consumption of the lick is variable and uncertain; some cows eat a lot, others none at all. In practice these salt boxes are often neglected by both the stock and the owner.

Mixing the bonemeal with a palatable foodstuff is much to be preferred, as the farmer can then be sure that all animals consume their quota. This is relatively easy where the cows are bail-fed, that is if the cows will eat food containing bonemeal. It is unfortunate that bonemeal can make rations so unpalatable to some cows that there are many dairymen who refuse to use it. Certainly cows can be trained to eat bonemeal supplements. I know herds where as much as six ounces daily is consumed with relish by the top cows. There is no doubt, however, that cows in other herds show a pronounced distaste for even traces of bonemeal. Where this is so an alternative source of phosphorus must of necessity be used. Only limited supplies of bonemeal are available. For this reason also the farmer must utilise other sources of phosphate.

Average milking cows should receive about two ounces of bonemeal per head daily. The requirements will vary according to milk production and the quality of the grazing. Good cows should receive up to four ounces of bonemeal daily. Heifers on dry feed will grow better and stock more readily if bonemeal is made available.

Boneflour.

This consists of the mineral residue from bones which have been extracted in the preparation of products such as gelatine. It is sold as a fine whitish powder which has very little odour and can easily be mixed with other foodstuffs. It is a popular and useful supplement but has the disadvantage that regular supplies cannot be guaranteed. Boneflour is used in the same quantities as bonemeal.

Di-calcic Phosphate.

This is prepared from phosphatic rock and in pre-war years was used in considerable quantity. It is an expensive source of phosphorus, however, because of the difficulties of manufacture. As the preparation also involves the use of sulphuric acid, which is now in short supply, the further use of di-calcic phosphate is not recommended.

Superphosphate.

Following the field trials described in a previous publication (Snook, 1949) superphosphate has become quite a popular source of phosphorus for livestock. Previously superphosphate had received little consideration for direct use as a mineral supplement although it was cheap and readily available. This neglect was chiefly due to the assumption that the fluorine present would prove toxic. I have considered this factor carefully and field trials to date have supported my contention that superphosphate is a safe source of phosphate for livestock if used as described below.

Untreated Superphosphate.—The mixing of dry superphosphate with other foodstuffs, or in mineral licks is NOT recommended. Half the bulk of commercial superphosphate consists of calcium sulphate or gypsum, an inert, unpalatable waste product of no food value to animals. A certain amount of calcium fluoride is also present (about 0.7%F.). The gypsum and some of the fluoride can, however, readily be separated from the valuable water soluble calcium phosphate by mixing the superphosphate with water. The useless materials quickly sink to the bottom of the container leaving the phosphate in the clear solution above. There is no point in using "straight super" when a purified product can be prepared so simply.

Superphosphate in the Drinking Water.—During the summer of 1948-49 tests were carried out to determine if the phosphorus requirements of dairy cows could be supplied by adding superphosphate to the drinking water. This method has become quite popular and is now widely practiced where stock have to drink water which has been treated. Up to 5 lb. of superphosphate can be added to every 100 gallons of water without reducing the palatability. On most farms, the use of 3 lb. of superphosphate in every 100 gallons of water is adequate, if the treatment is maintained throughout the

summer. At this rate of supplementation a cow drinking the usual ten gallons of water daily will obtain as much phosphorus as is present in 3½ oz. bonemeal. A cow on this intake throughout the summer will calve down in the autumn with an abundant reserve of phosphorus, in contrast to the depleted condition so commonly seen. This should encourage maximum milk production and reproductive efficiency.

Methods of Using Superphosphate in the Drinking Water.—The methods used to supply water treated with superphosphate will vary according to conditions. On the properties where the tests were made, stock are watered from concrete containers holding about 600 gallons, which are kept filled by the use of ball-cock taps. These large containers are treated by adding daily one pound of superphosphate for every three cows drinking from the trough on the assumption that each cow will drink about 10 gallons of water daily. It would be more exact and fool-proof, of course, to treat a container full of water by adding 3 lb. superphosphate per 100 gallons, using this, refilling, and again treating with superphosphate. In the wheatbelt where the stock water is conserved in dams, it would be a simpler matter to treat the dam in one operation at the beginning of summer so making certain that all stock drinking this water would be assured of an adequate phosphorus intake. Incidentally, the gypsum in the superphosphate will clear the suspended mud from water—treated water is always crystal clear.

Some farmers are adding the superphosphate to the large tanks from which drinking water is reticulated. The necessary periodic removal of the gypsum from the bottom of the tank may prove difficult. Perhaps this could be avoided if the required amount of superphosphate is mixed with two or three times its weight of water (5 lb. superphosphate to one or two gallons) and left to settle. The clear supernatant fluid will contain most of the phosphate and this could be decanted into the tank, the useless sludge being thrown away. Doubtless many "tricks" and modifications will be used but there seems no obvious obstacle to the wide use of "superphosed" drinking water. This would permit all stock to build up their phosphate reserves during the summer months when normally the reserves of this mineral are being depleted. The possibility must even be considered that if the cows freshen in the autumn with adequate reserves there may be no need for further supplements while good quality green feed is available.

One possible disadvantage may be mentioned. The addition of phosphate to the drinking water encourages a prolific growth of green algae and similar water plants. This growth is not necessarily harmful but it may offend those who like to keep the water troughs clear of plant growth. It must be remembered, of course, that plant life which appears in treated waters will support fish. Dams in the wheatbelt, for example, would grow edible fish if fertilised with superphosphate at the rates suggested above. In India and Palestine, for example, fish ponds are an important source of food and these ponds would not be profitable without the use of phosphatic fertiliser.

Concentrated Solutions from Superphosphate.—Treatment of the drinking water is of little use during the winter months or where alternative water is freely available. A concentrated solution of water soluble phosphate can be prepared, however, by thoroughly mixing superphosphate with water at the rate of 5 lb. per gallon, i.e., with double its weight of water. The clear solution obtained when the mix is left to stand is very rich in phosphate, one pint containing as much phosphate as 6 oz. bonemeal. It is of interest to note that very litle fluoride remains in solution, all but a trace being precipitated with the gypsum sludge. The concentrated solution is now widely used to damp down food fed in the bails, as half a pint per head daily constitutes a very worthwhile supplement. It can also be used to damp down meadow hay or chaff fed to cows in the field. Farmers report that stock prefer the treated hay. If hay could be sprayed with the concentrated solution as it was being stacked, the phosphorus requirements of the stock eating the fodder could be assured.

The concentrate is particularly useful when only a little food is given in the bails. Some farmers, for example, use only enough bran to soak up the fluid added and the cows eat this readily. By attaching small feeding boxes to the doors or sides of walk-through bails cows can be given their supplement even though the rate of passage through the shed is rapid.

Preparation.—Superphosphate should be added to water at the rate of 5 lb. per gallon. Mix thoroughly with a stick and then pour from bucket to bucket about six times. Where the containers are too large to do this, stir thoroughly from top to bottom using a mixer made like a cream stirrer.

When all the water soluble phosphate has been dissolved further stirring is unnecessary. In practice, however, it may be an advantage to have two or three containers which can be used in rotation. If these are placed in a handy position it is not much bother to give them all a thorough stir several times a day.

On being left to stand, the undissolved material quickly settles to the bottom leaving a clear fluid which can be dipped off as required. The sludge on the bottom should be thrown on the manure heap before the next batch is prepared.

Testing Strength of Solutions.—Obviously a certain amount of mixing is essential to make sure all the soluble phosphate has gone into the solution, but no one wants to waste time stirring unnecessarily. By using an hydrometer to obtain the specific gravity, the strength of the solution can be read in a matter of seconds. Suitable hydrometers with a long, easily read scale from 1.000 to 1.200 can be purchased for about 14s. A saturated solution gives a reading of 1.100. If the value is much less than this either more stirring or more superphosphate is needed.

Effect on Metal Containers.—Although the saturated solution is strongly acid in reaction, it does not appear to be corrosive. Apparently a film of iron phosphate is formed on iron surfaces and this may be protective from, rather than inducive of, rusting. So

far kerosene tins and galvanised buckets have been used at this laboratory without apparent damage and superphosphate has been added to galvanised tanks and troughs without any reported damage.

Rock Phosphate.

This is the cheapest source of phosphorus available and the ground rock is very suitable for mixing with foodstuffs. Overseas, however, ground phosphatic rock is considered too dangerous for use as an animal food because of the fluoride it contains. Fortunately, the rock used almost exclusively in Western Australia comes from Christmas Island and contains less than half the fluoride (1-1.7% F) present in most overseas samples (3-4% F). In view of this fortunate circumstance, tests have been under way for a year to determine if finely ground Christmas Island rock can safely be used as a mineral supplement. The results to date have been encouraging, but it will be necessary to feed the rock for another two years or more before definite conclusions can be drawn. Meantime, farmers should continue to use supplements known to be harmless.

Reference.

Snook, L. C. (1949), *J. Dept. Agric. W. Aust.*, 26:169.

Pig Raising as an Adjunct to Dairy Farming

B. WILLIAMS, Agricultural Adviser

(This article contains also some abstracts from earlier publications by officers of the Department of Agriculture)

GENERAL CONSIDERATIONS

THE rearing of pigs for both the porker and baconer trade has been carried on in conjunction with the production of butterfat for many years and the results have shown that such a system can provide a sound practical means of utilising the skim milk to advantage. The use of skim milk coupled with the grazing of suitable types of pasture will provide a large proportion of the foods necessary for both pork and bacon pig production. As the cost of food is considerable in the cost of production, this provides a major economy and places the butterfat producer at a distinct advantage compared with other pig raisers. This factor is of importance during times when wheat, and other grain, command a high price, as grazing will reduce the quantity of grain necessary. Similarly when protein-rich pig foods, notably meat meal, are in short supply or high priced, skim milk can entirely replace these foods.

It would appear that pig raising is a sound economic adjunct to butterfat production. This is correct as long as the type of pigs raised is acceptable to the market; and the number of pigs raised, and the

system of management used, does not interfere unduly with the management of the dairy herd. To explain these points they are discussed hereunder:—

TRADE REQUIREMENTS.

The trade requirements in earlier years were governed to a large extent by the requirements of the market in Great Britain as a large proportion of the pig meat produced in this State was exported in that period. While there is still a huge demand for all kinds of meat in Great Britain, it is logical to look forward to the day when supplies will be more adequate and discrimination fully exercised by buyers, in respect to quality.

In the last few decades there has been a trend in consumer-demand towards smaller and leaner joints, with the natural consequence that extra large and fat carcases have claimed lower prices than those providing cuts of the right size, with plenty of lean meat, balanced with a nice proportion of fat.

As a consequence the pig buyer endeavours to satisfy the consumers and so encourages the production of pigs which will conform to a particular standard of *conformation* rather than a particular breed.

In general, the trade requirements are:—

(i) For a carcase which is not overfat, of good length, light in those portions of lower market value (i.e., head, feet shoulder); and

(ii) A carcase which is well developed, having a good depth of lean muscle surrounding the bone structure in those parts which command the higher prices (i.e., hams and loin).

CONFORMATION OF PIGS.

The requirements of standard carcases for pork and bacon in this State may be summarised as follows:—

The carcase must be that of a castrated male or virgin female pig.

The middle portion from the first rib to the hip or aitch-bone must be long. Head and neck must be light. Ribs should be well sprung and not sloping rapidly downwards from the backbone.

The top line should be slightly arched from head to tail, which should be set high. The shoulders should be smooth and evenly rounded.

Back fat should be even, without areas of excessive thickening, particularly on the shoulder, and the depth of fat should decrease slightly towards the rump. Fat should not be more than 1½ in. thick at the shoulder in the bacon pig.

The underline should be even, firm and straight without indication of excessive fat.

The shanks should be short, bone fine, and the ham free from wrinkles. The ham should be well fleshed down to the hock and well filled out on the inner side.

The fat in the carcase should be white and firm.

The skin should be thin, light flesh coloured, free from wrinkles and deep rooted bristles and must be devoid of skin pigmentation.

Carcases which conform to the above will have a higher percentage of the higher priced cuts and these will command the top price. This can be achieved by the farmer by attention to good breeding, adequate feeding and correct management.

The following photographs will serve to illustrate the points mentioned above.

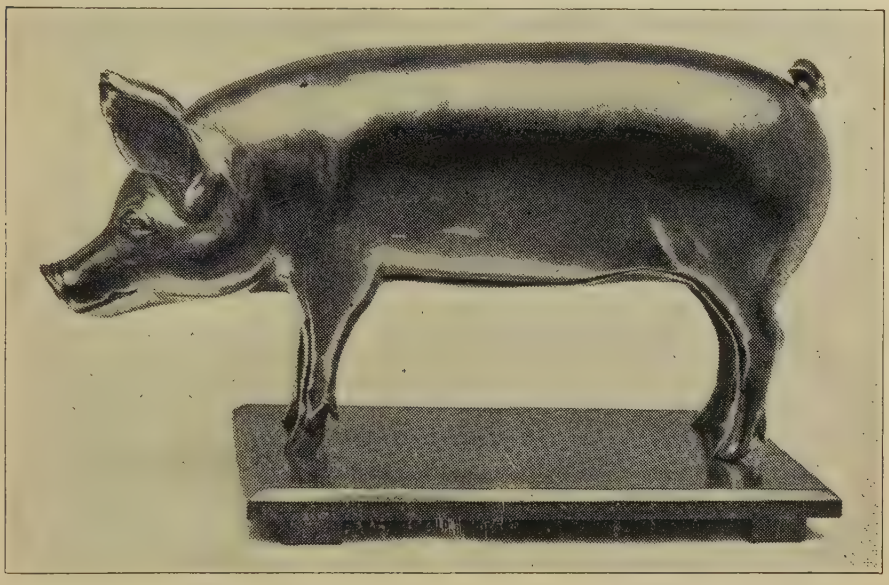


Fig. I.

AN EXAMPLE OF GOOD CONFORMATION.

Model of standard type of bacon pig, in chrome-nickel, prepared by Western Australian Branch of Australian Pig Breeders' Association, as a guide to breeders and farmers in the selection of breeding stock for bacon production.

Descriptive terms used in the Trade.

Trade terms which may be used in marketing are as follows:—

	Approx. age.	Approx. weight.
Sucker or sucking pig	6 weeks	25lb. live weight.
Weaner	8 weeks	35-40lb. live weight.
Slip	10 weeks	40-55lb. live weight.
Store	12-14 weeks	55-85lb. live weight.
Light porker	4 months	90-120lb. live weight.
Heavy porker	4-5 months	120-150lb. live weight.
Light baconer	5-6 months	140-160lb. live weight.
Heavy baconer	6-7 months	180-200lb. live weight.

Back fatter—Good quality pig, any age, over bacon weight.

Stag—Old castrate boar, any age.

Chopper—Inferior quality pig, any age over bacon weight.

Gilt—A young sow, if mated at about eight months may be termed a gilt until she has farrowed.

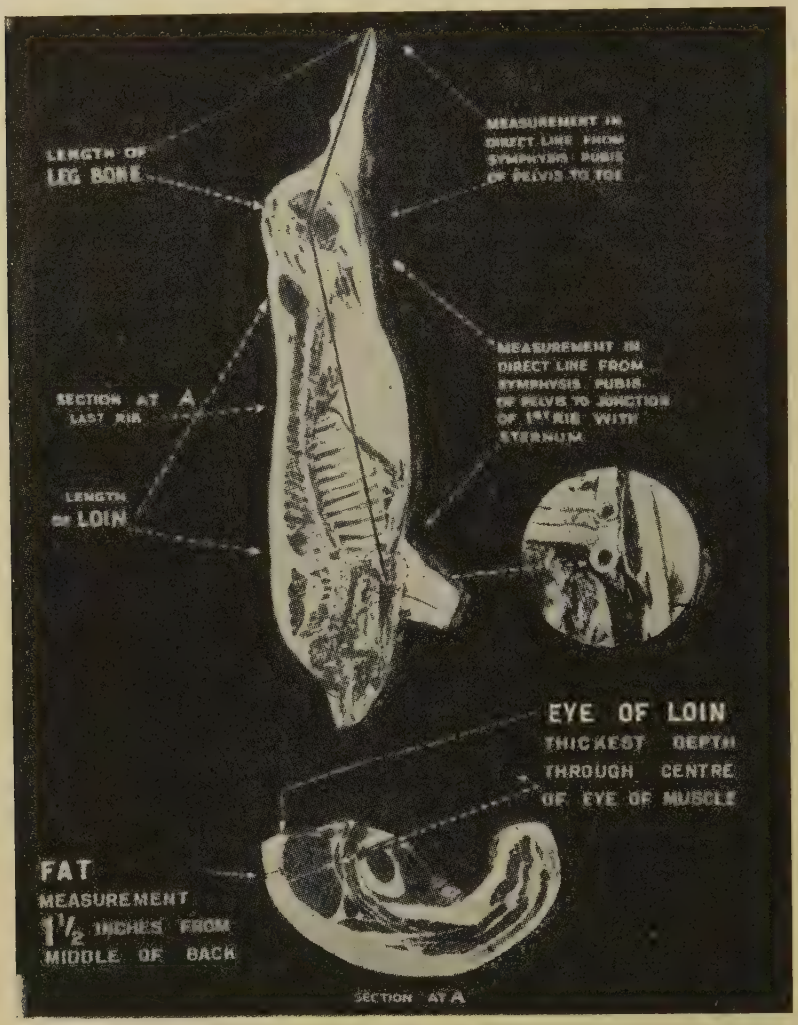

LENGTH OF LEG BONE
MEASUREMENT IN DIRECT LINE FROM SYMPHYSIS PUBIS OF PELVIS TO TOE
MEASUREMENT IN DIRECT LINE FROM SYMPHYSIS PUBIS OF PELVIS TO JUNCTION OF 1ST RIB WITH STERNUM
SECTION AT A LAST RIB
LENGTH OF LOIN
EYE OF LOIN
THICKEST DEPTH THROUGH CENTRE OF EYE OF MUSCLE
FAT
MEASUREMENT
1½ INCHES FROM MIDDLE OF BACK
SECTION AT A

Fig. II.
Points to note in a good bacon carcase.

[*Photograph by Jos. B. Swain; produced for the New Zealand Evaluation Committee.*]

Breeds of Pigs.

Many breeds are recognised throughout the world, but England has achieved a great improvement in various breeds which have gained popularity as being of special value in improving native types in various countries. Even in England, some twelve or more distinct pure breeds are recognised, which offers complications in the purchase of foundation stock. In this State however, three breeds predominate; the Berkshire, the Tamworth and the Large White. All the requirements of the existing market, both local and export, can be met by using these breeds, which simplifies the work of producing a suitable standard carcase.

Departmental policy is to advise the use of the Berkshire, the Berkshire X Tamworth, the Large White or Berkshire X Large White. The Large Whites are particularly useful when heavy weight baconers for export are required.

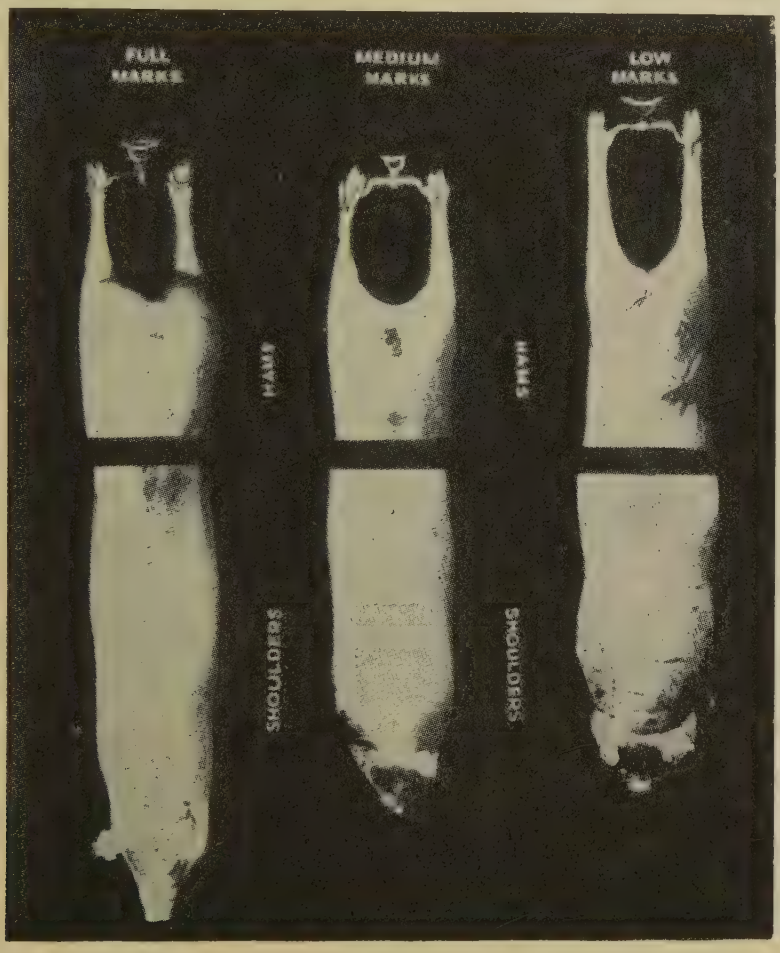


Fig. III.

Length of carcase is important in assessing the value of a baconer.

[*Photograph by Jos. B. Swain; produced for the New Zealand Evaluation Committee.*]

The Berkshire.

The Berkshire is one of the oldest improved breeds from England, and is the most widely distributed throughout the world and does well under a wide range of climatic conditions. They are of medium size; originally larger than Poland-China, smaller than Large Yorkshire, Tamworth and Large Black. The breed is generally adaptable for pork and bacon and will fatten at any age. They do well under grazing

conditions, providing the quality of the feed is suitable, and dress out well, with well-mixed fat and lean. Crosses with Berkshire are used largely for both pork and bacon. Their breeding qualities are reasonable and sows produce fair to good litters and are reasonable mothers.

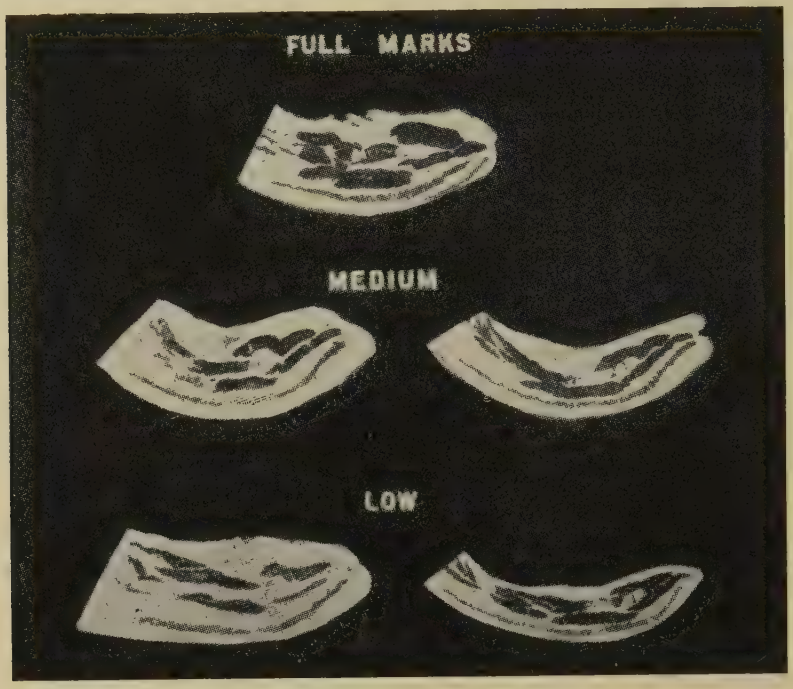


Fig. IV.

The proportion of muscle and fat is important in assessing the value of a baconer.

[*Photograph by Jos. B. Swain; produced for the New Zealand Evaluation Committee.*]

Conformation of the Berkshire.

The principal points to look for may be summarised as follows:—

Head—medium, broad fleshy, wide between eyes, dished with short snout.
Ears—fine, inclining forward.
Jowl—full, firm and symmetrical.
Neck—short, broad and muscular.
Shoulders—sloping and well rounded, not heavy. Thick through chest.
Back—broad and slightly arched.
Barrel—ribs well sprung and deep. Strong well filled loin.
Rump—wide, long and squarish.
Legs and Feet—short, straight and set well apart.
Skin—smooth and free from wrinkles.
Colour—Black with white blaze on face. White feet and white brush on tail.

Fig. V.

The photograph shows the comparison between a good quality bacon side (left) and an inferior carcase (right). Compare the distribution, development and proportion of fat and muscle in the two photographs.

[*Photograph by Jos. B. Swain; produced for the New Zealand Evaluation Committee.*]

The Improved Berkshire.

As a result of continued selection of bacon types of sows and boars, the improved Berkshire, or, as sometimes called in other years, the Canadian Berkshire, was developed. It differs little in conformation from other typical bacon type pigs but it is rather longer in the snout and lighter in the head and jowl than the original type. The shoulder is finer and more sloping with a greater length in proportion to weight.

Tamworth.

The Tamworth derives its name from Tamworth, Staffordshire, England, and has been bred for a long time. It is a large pig, second in size to the Large Yorkshire and a hardy and vigorous breed, suitable to various climatic conditions and do well under open grazing conditions. The carcase is typically leaner than most breeds and for this purpose is most suitable for crossing with other breeds. Sows are excellent mothers and generally have good litters.

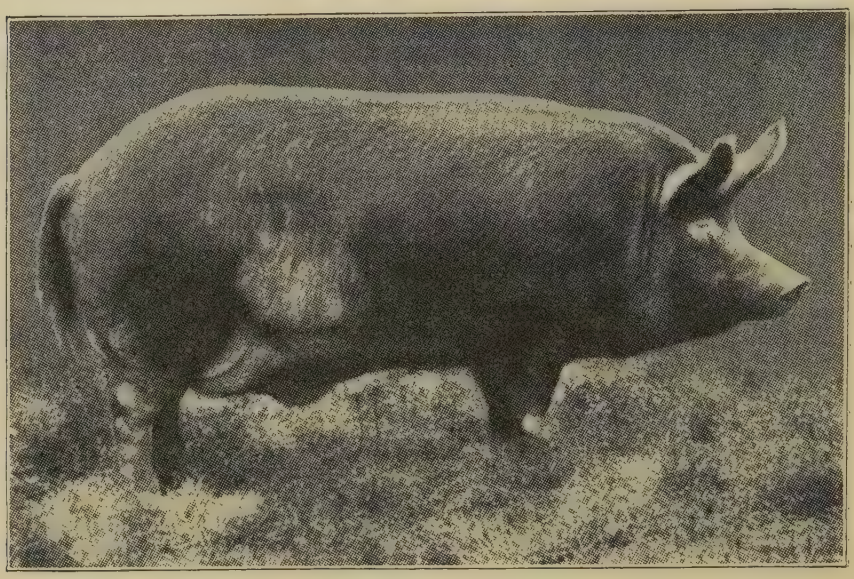


Fig. VI.
TAMWORTH BOAR.
Improved type; note hams, capacious body but small head.

Conformation of the Tamworth—Principal Points.

Head—light and lean with good length, tapering to snout.
Ears—moderate size, erect and forward.
Jowl—light.
Neck—long, deep but not wide, and tapering head.
Shoulder—sloping with good heart room.
Back—moderately wide, good length and slightly arched.
Barrel—long and well sprung.
Rump—deep, fairly full and well rounded.
Ham—large, well filled and rounded.
Legs—moderately long and well placed.
Skin—smooth, free from wrinkles without coarseness in hair.
Colour—bright golden red (no black).

Large White (Large Yorkshire).

The Large White is a robust and prolific animal, the sows are good mothers and generally are able to rear large litters of hardy pigs. They cross well with other breeds of early maturing qualities. The Large White is a good grazer in cool climates but the white hair and unpigmented skin make the breed susceptible to sun scald unless reasonable shelter is available.

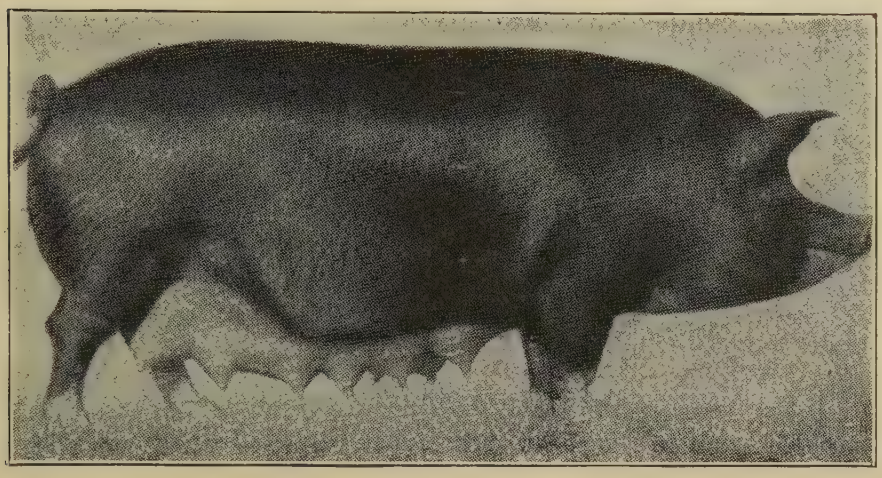


Fig. VII.
A typical brood sow of the improved type Berkshire.

Conformation of Large White—Principal Points.

Colour—white, long straight silky hair.
Head—long and light, wide between the ears.
Ears—thin, long, slightly inclined forward.
Jowl—small and light.
Neck—long and muscular.
Shoulder—oblique and narrow on top.
Back—long and straight.
Barrel—deep and well sprung.
Hams—broad, full and meaty to the hocks.
Legs—straight, with flat bone, and well placed.

It may be well to remember that carcase type may be more important than breed in rearing pigs commercially in order to satisfy the requirements of the market.

Choice of Breeds.

The results obtained under Western Australian conditions have shown that the Berkshire and Tamworth breeds and their crosses are most suitable, generally, for the production of both bacon and pork carcases. This does not condemn other breeds however, but types of sows and boars should be selected which conform to the required conformation, i.e., good length, light shoulder, well developed hams, light jowl and small head and not excessive fat development.

Average results show no greater percentage of high quality carcases with other breeds than with the Tamworth, Berkshire, Large White and their crosses. Curers in this State also, advise that these types are suitable for their purposes; and a large and profitable export trade in pork has been built up by New Zealand, principally with pigs of the Tamworth-Berkshire cross. For this reason under Western Australian conditions the recommendation is made that good type breeding stock from these three breeds should be selected by dairy farmers intending to maintain a limited number of sows.

Selection of Breeding Stock.

The result obtained depends to a great extent upon the selection of suitable foundation stock. Any breeding animal should be in excellent health with evidence of a strong and vigorous constitution and have a good conformation.

Sows.—The value of a breeding sow is determined by the number of litters she rears and the number of pigs born in each litter, their birth weight and the health and condition of the pigs from birth to weaning, and the suitability of the litter to the trade requirements.

A sow which produces litters of a reasonable number and showing evenness in the size of the piglets, is preferable to one whose litters vary in the size of the young pigs or whose litters are small in number. Litters of seven to ten are generally most satisfactory from the breeder's point of view.

In selecting sows, conformation, health and vigour are of importance. The sow must be sound, healthy, and bred from sound healthy parents who have produced large litters. She should be docile in temperament and of an active thrifty disposition with a capacity to consume large quantities of food to benefit the litter during pregnancy and to provide them sustenance during the subsequent lactation.

Soundness of constitution and robustness are indispensable features associate with strong jaws, open nostrils, good width between the eyes, sloping shoulders, strong straight or slightly arched back, long deep barrel and sturdy straight legs. The skin should be smooth and free from wrinkles. Teats should be 12 to 14 in number, evenly placed and properly formed.

Boars.—Of particular importance is the selection of the boar as he may be responsible for well over a thousand progeny during his life. The economic life of a boar is generally considered to be five to six years. On no account should "scrub" boars be used—select from pure-bred stock—false economy here may cost the farmer dearly later on. If possible a boar from a large litter and from a strain of sows which throws large litters should be chosen. In addition to the pedigree there are certain characteristics which should be shown in any boar of any breed, i.e., strength and masculinity without coarseness of skin, or excessively heavy shoulers or shields.

When the boar is selected as a weaner, attention should be given to his feeding to ensure the normal unchecked growth and the development of a good strong frame with ample muscle development. The importance of adequate feeding on protein rich foods during the growing period should be appreciated. It is wise to remove the young boar from sows at an early age, say three to four months and provide a separate pen for him with sufficient room for exercise and provision of ample shade, shelter and water.

Using the Boar.—A boar should not be used for service until eight to nine months old and in the first season should be used on a limited number of sows only, possibly up to 12 sows if the services are spaced at intervals. In the following seasons up to 50 services may be obtained successfully if he is used judiciously. On no account should the boar

be allowed to run with the sows—the practice is wasteful and no record can be kept of services or farrowing dates. While the boar is growing, exercise and access to young pasture will be found an advantage. If pasture is not available other green stuff such as vetches, peas or lucerne should be made available.

Mating.—As mentioned earlier a boar is generally fit for light services at nine months if feeding and environmental conditions have been good. Earlier use of boars is not recommended and if, for any reason, the animal is not as forward as it should be it may be wise to delay service a little longer. Unrestricted service occurring when the boar is allowed to run with the sows is undesirable. The boar should be housed separately and his services controlled.

Sows in good forward condition generally come in season when from three to five months old. The oestrum lasts from two to three and sometimes four days and occurs every three weeks approximately until pregnancy occurs, the sexual cycle ranging from 19 to 21 days. Ovulation occurs one day before the end of heat. This indicates that sows are best mated late on the second day.

Young sows should not be mated too early in their life as the ensuing pregnancy puts a big demand on the sow in maturing the embryos and later in the production of milk. This may adversely affect the growth of the sow or lighter litters may be produced. If the sow is undersized, the milk flow may be restricted and the growth of the piglets affected. For this reason sows should not be mated until 10 months old unless they are very forward in their development.

"Flushing" before Mating.—In general a rising or improving standard of nutrition at breeding time is most conducive to high fertility. Flushing consists essentially of suddenly increasing the level of feeding, particularly the protein portion of the ration, some two or three weeks prior to mating.

To obtain good results from this practice, sows should not previously have been in heavy condition, rather light active condition being preferable to fat condition, as the breeding qualities of a sow, as with most animals, can be impaired by overweight.

Pregnant Sows.—The normal gestation period is 16 weeks or 112 days. After farrowing the sow will come in season in three or four days' time and will take the boar. This is not advisable, however, as it puts a heavy strain on the sow, and the litter has to be weaned at an early age. It is better to delay service until after the litter is weaned—this ensures that the piglets get the best possible start in life and also give the sow an opportunity to build up her condition again after the strain of feeding the youngsters. Thus three litters in two years is reasonable and is recommended.

The feeding of the pregnant sow is an important consideration. Remember that she must receive adequate quantities of the right kind of foods, i.e., those rich in protein-forming substances. Grazing on young leguminous pasture is of great assistance and is cheap. Sows should not be permitted to get overfat—the effect on the litter may be the same as if the sow were semi-starved, in that the size of the individual piglets tends to be smaller and overfat sows may not have a good flow of milk.

"Steaming Up" before Farrowing.—"Steaming up" is the practice of feeding protein-rich, non-fattening foods during the latter stages of pregnancy to encourage a maximum milk flow after farrowing.

In the mammary glands the milk secreting tissue lies in a protective basket-like framework of supporting bands of connective tissue and is surrounded by protective fat tissue. If the development of these two latter types of tissue is excessive the gland tends to be "fleshy" and low producing. Feeding the sow on a fattening diet during late pregnancy increases the amount of fat tissue in the mammary glands and the growth of the milk secreting tissue (or alveolar tissue) is retarded.

The practice of steaming up induces a maximum development of secretory tissue upon which the subsequent milk yield is dependent.

Farrowing Time.—Some 10 or 12 days before farrowing the sow should be housed in a separate pen. The feed may be reduced somewhat as there will be little exercise. The food during this time should be laxative. This can be achieved by the use of succulent green material, the use of bran, or if no natural laxative food is available the use of 2-4 oz. of Epsom Salts in the feed is deemed necessary.

Some eight to 12 hours before farrowing the sow will become restless and will make a "nest" of straw or other material. There should not be too much straw present in the farrowing pen lest the young pigs should get underneath this and be suffocated by the sow. The pen should be well sheltered, dry and free from draughts. A timber rail around the inside of the shed, some 8-9 in. from the floor and a few inches from the wall allows an escape for the young pigs when the sow is lying down and avoids the young being crushed. Farrowing crates are sometimes used to reduce the mortality in the young pig, and farrowing pens with sloping floors have given good results.

Raising the Litter.—After farrowing the sow should receive no food for 24 hours and then the food should be in the form of a slop and laxative in nature—crushed oats and pollard in equal proportion in skim milk being a favourite and satisfactory feed. **At all times plenty of clean, cool water should be available.** The quantity of food necessary varies with sows of different weights and size of litter. An average figure would be 3-4 lb. per day for the first few days increasing to 6-8 lb. per day at the end of the first week. Feeding three times per day in the early lactation period is preferable. Grazing on young pasture should be available whenever possible. If no green feed is available about ½ lb. of good chaffed meadow hay fed with the slop is advantageous.

Undersized or weak piglets should be destroyed as they seldom develop into thrifty animals.

It is essential in order to provide for maximum development of suckers and to avoid any check to growth at weaning that the young piglets be provided with feed apart from the mother. This may be accomplished by penning off a small trough in the corner of the breeding pen, or yard, by means of a hurdle wide enough between the bottom rails to allow the piglets access to the trough and close enough to keep out the sow. This creep feeder should be made avail-

able to the piglets when two weeks old and its use be continued until weaning, allowing approximately ¼-½ lb. feed per head per day at two week and increasing the rate to 1-1½ lb. at weaning or 8-9 weeks old. Suckers given access to creep feeders will thus become accustomed to supplementary feed, be brought to maximum weights at weaning time, and suffer less check when weaned. The value of creep feeding, therefore, cannot be over emphasised.

Weaning.—Many farmers rearing pigs tend to wean the litter at too early an age, sometimes at six or even five weeks. This is too young and the piglets receive a check to their growth and may not recover for some weeks. Experience shows that if weaning is delayed until the pigs are 8-10 weeks old much better growth rates can be obtained.

The time of weaning, however, depends on the lactation of the sow and it seems necessary that many dairymen should have a better appreciation of the food requirements of the sow both during pregnancy and after farrowing and how the milk flow may be affected.

Between conception and parturition the sow may have to increase her body weight from 40-80 lb. depending on her age and size. This extra weight is occasioned by the growth of the embryos, the development of the mammary system, extra body condition of the sow, which will serve as a reserve for the subsequent lactation, and the normal growth and development of the sow herself.

The food requirements are greatest towards the end of the gestation period and this is due to the changes which occur during pregnancy which may be outlined as follows:—

Consider the period of pregnancy to be divided into three roughly equal periods, then, during the first period (i.e., up to about six weeks) the rudimentary nervous and circulatory systems are developed in the embryos. This, however, does not occasion much increase in weight.

During the second period (i.e., from about 6-11 weeks) the vital organs of the embryos are developed i.e., the heart, liver, lungs, intestines, etc. At the end of this period, however, the embryos are still relatively small and it is not until the last few weeks of pregnancy that a big increase in weight occurs. This is due to the rapid development of flesh and muscle tissue in the embryos and the lengthening and hardening of their skeletal structure. At the same time as this latter change the mammary glands of the sow develop quickly and the secretation of milk begins.

It will be realised from the above that the food requirements of the pregnant sow is little more than normal just after mating but will increase markedly towards the end of the gestation period.

This extra food must be rich in proteins as explained earlier in this discussion under "Flushing."

In suggesting that weaning should occur at 8-10 weeks therefore, it must be borne in mind that the sow may not be potentially capable of such a long lactation, but, if she is, then the dairy farmer must aid her in the lactation by adequate feeding both before and after farrowing.

When it is decided to wean the litter the sow should be removed. By removing the sow and allowing the weaners to remain the latter suffer less than they might in new strange surroundings. As soon as the young pigs have become used to the absence of the sow they can be removed to larger quarters where they will remain.

Rearing Orphan Pigs.—Occasionally young pigs may be left without a mother but their successful rearing can generally be accomplished with a little patience and care if it is not possible to distribute the motherless pigs among other sows with litters of comparable age.

A feeding rack or "foster mother" may be constructed using two pieces of 6 in. x 1 in. board to form a baffle 1 ft. high and about 6 ft. long.

Through these boards, at a height of 6 in. from the ground and spaced 6 in. apart, 1 in. holes are bored. Through these holes the rubber teats of infant feeding bottles may be projected. Provision, of course, must be made for the baffle to be secure on the ground and the bottles firmly supported.

Orphan pigs will take to this system of feeding regularly from the first feed. They may be fed on cows milk to which a little cod-liver oil has been added. As with feeding any other young animal, cleanliness is an all important factor, and all foods should be given at blood heat.

At first the young pigs may not consume more than about 2 oz. per feed and should be fed every four hours. As the rate of growth is rapid, however, these feeds can soon be increased to 8 oz. each and the number of feeds per day reduced.

Frequency of Litters.—Three litters from each sow in 22-24 months is considered satisfactory. This allows her sufficient time to recondition her body between successive lactations, aids in prolonging the lactations and in producing litters of heavier birth weight. But many farmers aim at two litters per year in order to have the sows farrowing at regular times to have a supply of young pigs at the periods of the year when feed is available for fattening. At one farrowing each year it will be found usually that a number of the pigs must be disposed as slips or porkers unless purchased feeds are available at low cost. The economic life of a sow is generally considered to be 6-8 litters.

PRODUCTION COSTS.

It is difficult to make a reliable assessment of the production costs for pig meat produced as an adjunct to butterfat production as portion of the feed, skim milk, is a by-product of the farm and also there are times during the year during which there may be a surplus of young succulent grazing on which it is hard to determine the value. For this reason the farmer generally speaks of his net return in terms of so much per acre or so much per milking cow. It may be of value, however, to consider the cost of pig meat production on a basic system of grain feeding with the use of meat meal as a protein supplement, and the farmer could use this as a guide to determine his own production costs.

Such an estimate might include the following items of expense:—

Labour.
Capital outlay on premises and yards.
Depreciation on premises and yards.
Sows: Initial cost, useful life and residual value.
Boars: Initial cost, useful life and residual value.

Purchased feed costs to maintain—

(a) sows from mating to weaning the litter;
(b) litters from weaning to marketable size
(c) sows when not in pig or lactating;
(d) boars.

Value of grazing or fodder crops consumed.
Sundry expenses such as—

water;
rates;
commission on sale of stock;
transport;
yardage fees at market;
interest.

If some such cost structure as the foregoing be applied to a dairy farm there are several possible economies which might be effected. Some of these are discussed below, but every dairy farmer considering pig raising should study his own resources to determine what costs may be involved. Consider, however, the following:—

(a) *Labour.*

It is suggested that a dairy farmer should arrange to keep sufficient sows to provide for the efficient utilisation of the skim milk. A survey of the butterfat producing areas reveals that the cow to sow ratio approximates ten to one. This will allow about one baconer to be marketed annually per cow milked—many farmers fatten twice as many. If the farm is planned efficiently and the management good, the extra daily work involved may be carried out without loss of efficiency in other directions. Thus the additional labour cost of pig production may be nil, in fact, pig raising on dairy farms is an excellent means of turning spare time into cash.

(b) *Feeding.*

Skim Milk.—If a herd of 50 cows is envisaged the milk production would approximate 120 gallons per day. Supposing this yielded 105 gallons skim milk, then of this quantity it may be reasonable to expect 35 gallons would be used for calf feeding, leaving a balance of 70 gallons for pig feeding. For, say, five sows, and 30 young baconers reared from them this gives an average of two gallons per pig which would more than satisfy the full protein requirements; hence this cost may be adjusted.

Pasture.—Good grazing on pastures, fodder crops or root crops can considerably reduce the amount of grain and protein supplement required to produce a porker or baconer.

Pasture to be suitable for pigs must be young and succulent, clovers and grasses in the late flowering stage or later tend to be too fibrous for easy digestion and too low in protein compared with carbohydrates to induce muscle development rather than fat development in the pig. It may be noted that over-fatness in pigs is a frequent cause of lower market values.

No hard and fast rule can be laid down as to how much grain may be saved by feeding good pasture but a conservative estimate would be one-third of the total grain necessary in the estimate, providing that the grazing were maintained in good young succulent condition. The seasonal variations of pasture growth must be considered as well as the cost of the pasture itself. A considerable saving in the cost of wheat (or other grains or proprietary foods) can be achieved however with good grazing.

Fig. VIII.

Sows on good mixed pasture need little other feed until near farrowing time

Live Weight and Dressed Weight.

Frequently difficulty is experienced in working out the dressed weight of a carcase from the live weight of the pig. Average good quality bacon pigs conforming to the requirements of the West Australian trade generally lose about 28 per cent. on dressing.

An easy way to arrive at the *approximate* dressed weight is to multiply the live weight by seven and discard the last figure. Thus a live pig weighing 150 lb. would yield a carcase of approximately 105 lb. ($150 \times 7 = 1050$: Hence carcase weight equals 105 lb.).

The percentage of dressed weight to live weight will vary to some extent with the age and condition of the pig. Young pigs in low condition return a lower percentage dressed weight than old over-fat pigs (remember however, that over-fat condition is a serious defect in carcase quality).

Frequently buyers work on 66 2/3 per cent. to give them the dressed *value* at the factory.

The above considerations may help a farmer to determine his production costs.

THE MANAGEMENT OF PIGS ON DAIRY FARMS.

The aspects considered so far have dealt with the economic side of pig raising and little has been said on the important matters of management and accommodation of the pigs on a dairy farm.

It must be remembered that, in this article, pigs are regarded as an adjunct to the main business of butterfat production and as such should not interfere with the efficient running of the dairy herd. In order to accomplish this plan of the sties and pig paddocks, the system of water reticulation and drainage and the location of feed sheds, shelters, ramps and other features must be well thought out to ensure ease of operation in the daily routine tasks associated with pig husbandry. Some sugestions on these aspects are offered hereunder:—

Fences.

An essential consideration is the provision of adequate fences to confine the pigs of various sizes. The choice of material will be largely influenced by the price and availability of materials and labour but some additional cost and labour spent on good fences may avoid many troubles at a later stage. Pigs can be very destructive on crop and pastures alike and their grazing should be controlled at all times. Similarly pigs can be most objectionable if they gain access to farm buildings, water supplies, etc.

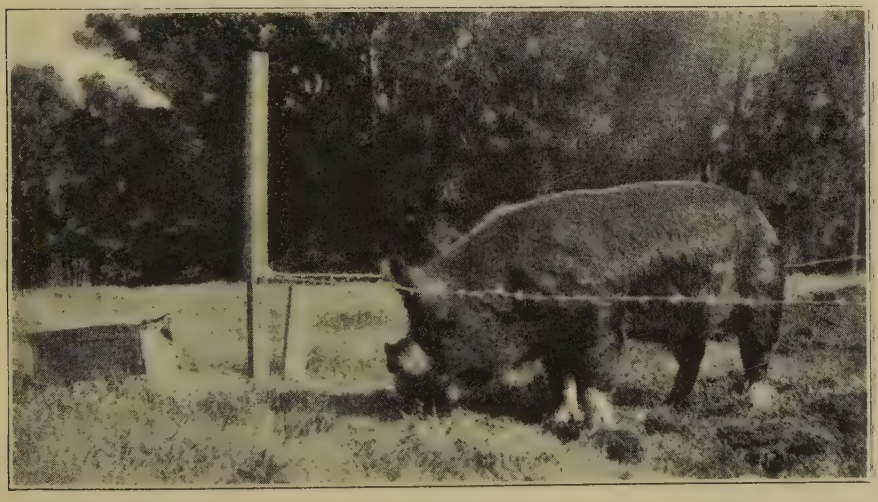


Fig. IX.

An electric fence is a handy aid in the grazing paddocks

Good fences for small runs, such as those adjacent to the sties can be made from wooden slabs, face cuts or discarded heavy timber. The weight of the material and the labour involved, however, limits the use of such fences to small areas.

For larger areas the use of woven pig netting or welded square mesh netting can be recommended.

A recent and cheap development is the use of an electric fence. These are easy to erect and may be moved with little trouble and form an excellent fence when rotational grazing may be desired.

The wire should be 12 to 14 in. above the ground. If baconers and slips are run together two wires may be used, one at six and one at 14 in.

Sties.

These must be dry, well drained and ventilated, with an impervious floor (preferably cement for ease of cleaning) and a waterproof roof. A finished baconer will require about nine square feet of sty space.

In constructing the sties remember that they may suffer some hard usage and that a good standard of hygiene will mean a good standard of pig.

An example of suitable housing is shown in the following photograph:—

Fig. X.
One satisfactory method of housing pigs

Yards.

Most pig keepers find that a small yard adjacent to the sty is very convenient. Frequently these yards become waterlogged and objectionable in winter. If the yards are sited on sloping ground drainage is an easy problem. Sandy or rocky situations are preferable to heavy loam or clay soils.

Layout.

A suggested layout is shown in Fig. XI. This could be varied considerably to suit the site and the size of the herd. Each sow is to be given a yard one chain by two chains for herself and her litter. The roomy race between the runs allows easy movement of pigs from yard to yard and with the provisions of a few hurdles to span it all the facilities for drafting are provided.

This system of yards could be worked on a slightly smaller scale if finance is limited, but in the long run the larger paddocks will show to considerable advantage.

The advantages of the large yards over small cramped quarters are many. They allow of cleanliness in management and a certain amount of grazing as mentioned above. They allow for cleanliness and comfort on the part of the pig, which is naturally a clean animal if given the opportunity, and above all they provide the surest safeguard against disease.

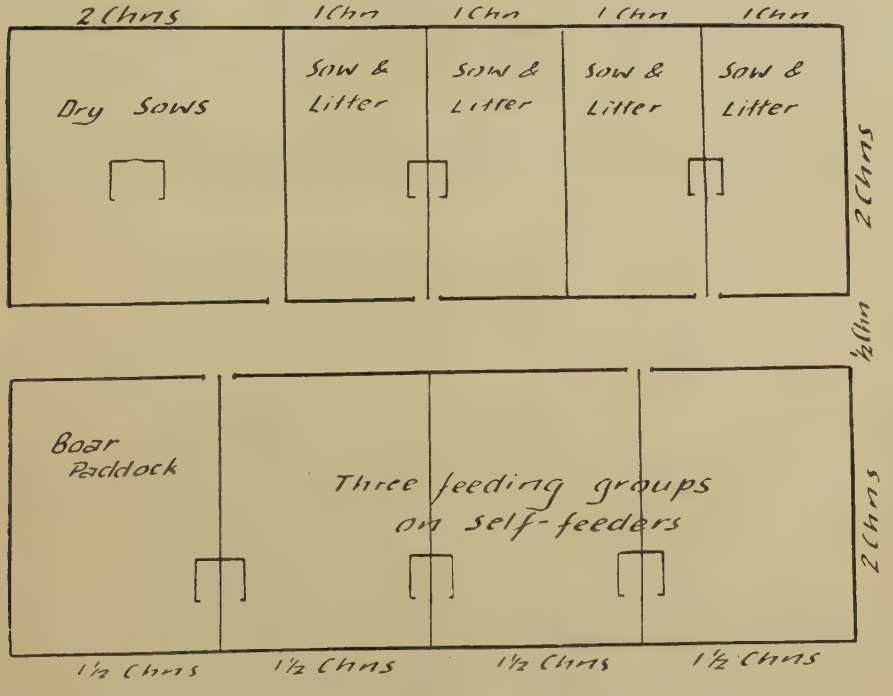


Fig. XI.

Standard of Hygiene.

All too frequently pigs are housed under very unhygienic conditions and the owner may wonder why his pigs fail to put on condition satisfactorily or why the mortality is high.

Pigs will be as clean as any other farm stock if given the opportunity. Lack of drainage, overcrowding and carelessness on the part of the farmer are the most important factors leading to a poor

Fig. XII.

A good example for a pig shelter.

Fig. XIII.

An easily constructed portable shelter for use when grazing pigs.

standard of hygiene. There are many farmers who clean out their milking sheds twice daily but never think of cleaning the pig sties all through the season.

A little thought and some attention can change many piggeries from an unwholesome, evil smelling, boggy area into one which the farmer will be justly proud to show his visitors and wherein stock can grow and reproduce in a healthy manner and yield the best results for the food consumed.

Open Air Keeping.

The running of pigs on pasture under a paddock system has much to commend it. Under free ranging conditions healthier animals can be produced. It is still necessary to provide dry, waterproof shelters for best results and these may be made portable if so desired.

Self Feeders and Feed Troughs.

There is no reason why self feeders should not be used for all ages of growing pigs, from the weaner stage onwards, for feeding dry mash or grain. They are economical in labour and relatively cheap to construct. Naturally wet foodstuffs such as skim milk, must be fed separately.

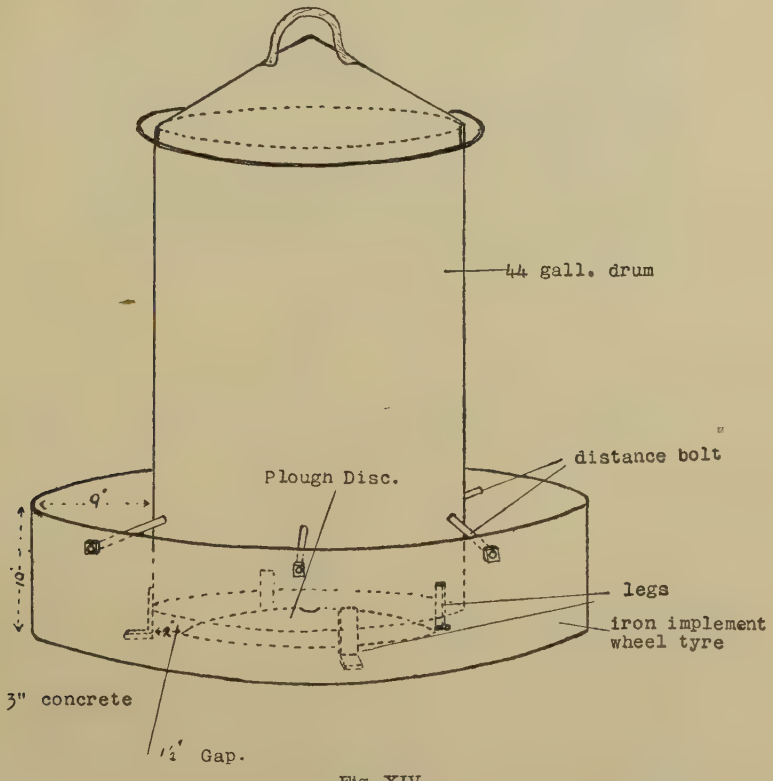


Fig. XIV.

A cheap and effective self-feeder made from an oil-drum

Self feeders which have proved successful at the Muresk Agricultural College are made from old 44 gallon oil drums. Both ends of the drum are removed; four L-shaped pieces of iron, which act as legs and keep the drum raised 1½ in. from the base of the feeder, are bolted to the drum; an old implement wheel tyre (such as a binder wheel tyre) filled with 3in. of reinforced concreted is used as a base (diameter of the base would be 18 in. greater than that of drum). This allows 9 in. all around the drum for feeding.

To allow the feeder to empty out, an old plough disc or cone should be placed in the centre of the base. This will carry the feed to the tray. The ideal width of the tyre used for the base is 10 in. as narrower types allow feed to be scattered and wasted. The drum is stood in the centre of the base and secured with four distance bolts. The provision of a lid for the drum completes the self feeder (see figures). This size self feeder has the advantage over larger types in that it can easily be moved to clean ground.

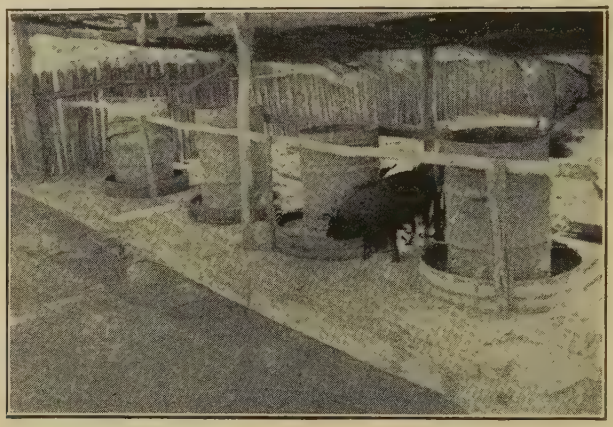


Fig. XV.
The self feeder in use.

Useful Data.

The weight per volume of various common dry foods may be of value in estimating the quantity which a particular self feeder may hold.

One 44 Gallon Drum of—

	weighs lb.
Wheat	330
Crushed Wheat	240
Oats	220
Crushed Oats	140
Maize	300
Maize Meal	270
Pollard	195

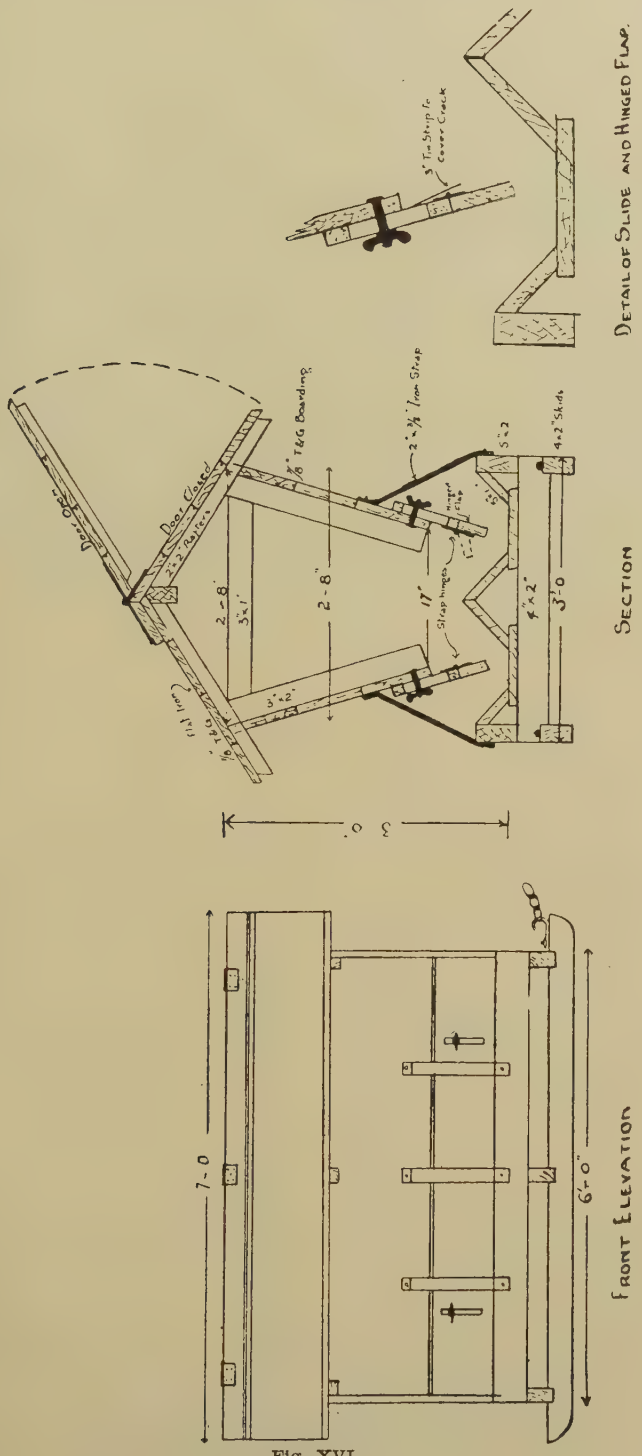


Fig. XVI.
Another type of self feeder is depicted in the above diagrams.

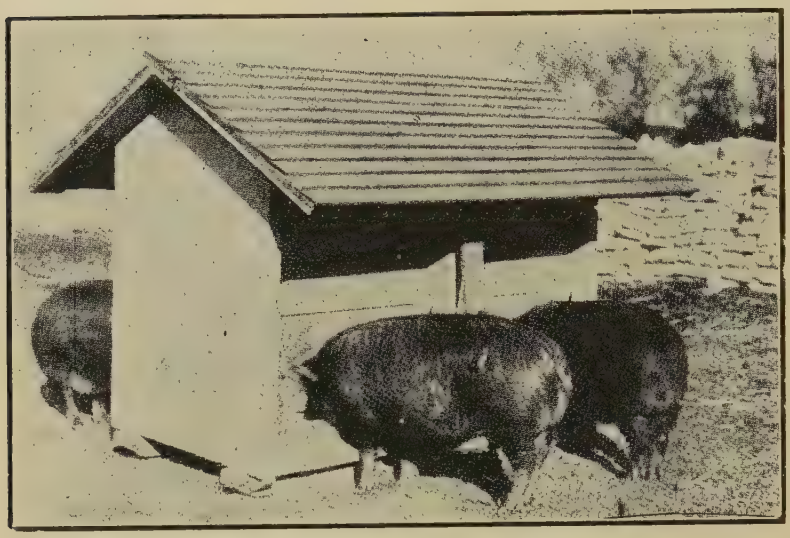


Fig. XVII

The self feeder in use.

One 4 Gallon Kerosene Tin of—

	weighs lb.
Meat Meal	30
Linseed Meal	30
Bone Meal	8
Ground Limestone	16

FEEDING OF PIGS.

The main considerations in feeding any animal to obtain a maximum of growth rate are:—

1. The capacity of the digestive tract and the average weight of dry matter which may be consumed per day.
2. The ability of the animal to handle fibrous foods.
3. The daily requirements of protein and carbohydrates and the *proportion* of these in food mixture.

With reference to 1. on p. 418, the pig has a relatively small stomach and hence cannot consume very large quantities of food. Such food, therefore should be more "concentrated" than those used for say sheep or cattle feeding.

With reference to 2. on p. 418, the pig cannot handle large quantities of fibre and for this reason the total fibre in the foods should not exceed 10 per cent. and should be lower with weaners and slips. With reference to 3. on p. 418 the proportion of digestible protein to digestible carbohydrates can be referred to (approximately) as the nutritive ratio. These nutritive ratios suitable to pigs of various classes are set out hereunder:—

Nutritive Ratios for Pigs of Various Weights.

	Digestible Protein.		Digestible Carbohydrates.
Sows with litters require	1	to	3.5
Pigs weighing 40-100 lb. require	1	to	3.5-4.0
Pigs weighing 100-150 lb. require	1	to	4.5
Pigs weighing 150-200 lb. require	1	to	5.0
Boars weighing 300-500 lb. require	1	to	5.5-6.0
Sows: Pregnant require	1	to	5.5

With the normal foods available for pigs under Western Australian conditions the quantity of protein available is generally the limiting factor. If a food contains sufficient protein, and the nutritive ratio is suitable and the fibre content is not too high, then the food (or the food mixture) will be suitable for pig feeding. The following figures will indicate the protein necessary.

Protein Requirements of Pigs.

Live Weight. lb.	Digestible Protein. lb. per day.
50	0.30
100	0.50
150	0.56
200	0.61
250	0.66

If the above data now be applied to the chemical analysis of various common foodstuffs as shown in the next table an indication of the suitability of the food may be obtained.

CHEMICAL ANALYSIS OF VARIOUS FOODSTUFFS.

Food.	Moisture.	Fibre.	Starch Equivalent.	Protein Equivalent.	Nutritive Ratio.
	%	%	%	%	%
Pasture—Mixed clover and Grasses. Young and Sueculent	80	3.2	14	4.5	1 : 2.3
Pasture—Mixed clover and Grasses in Flowering Stage	75	7.1	14	2.2	1 : 5.6
Rape	86	3.5	6	2.0	1 : 2.3
Peas—Feeding off Stage	80	3.7	9	2.2	1 : 3.5
Potatoes	75	0.9	18	0.8	1 :17.5
Swede Turnips	86	0.1	8	0.5	1 :13.1
Pumpkins	90	1.3	7	0.5	1 : 8.2
Oaten Hay	12	23.5	42	3.5	1 :13.7
Silage Grass and Clover	80	6.5	8	1.2	1 : 6.0
Barley Grain	13	2.7	71	6.8	1 : 9.7
Maize Grain	12	2.3	77	7.4	1 : 9.4
Oats Grain	11	10.2	62	7.6	1 : 7.6
Wheat Grain	11	2.1	72	8.0	1 : 8.3
Peas Grain	14	5.4	69	18.2	1 : 2.8
Meat Meal (average local)	10	2.0	67	43.0	....
Milk Whole	87	....	17	3.4	1 : 4.1
Skim Milk*	90	....	8	3.6	1 : 1.4
Linseed Meal	11	10.5	72	25.1	1 : 2.0
Bran Wheaten	10	7.5	44	9.9	1 : 4.5
Pollard Wheaten	10	5.8	69	10.6	1 : 5.6
Apples	84	1.0	12	0.2	1 :40.0

*It is convenient to remember that one gallon of skim milk is equivalent to approximately ¾ lb. of meat meal when considering protein supplements.

To explain the above table it can be seen that the young pasture is an excellent food, that is, low in fibre and having a low nutritive ratio. Similarly skim milk may be regarded as a protein concentrate and is an excellent food. On the other hand oaten hay, fed alone, would be quite unsuitable as, firstly the percentage of fibre is too high, and secondly, the nutritive ratio is too wide. Similarly potatoes, fed alone, are unsuitable as they are too low in protein.

It can be readily seen from these figures that suitable grazing of young pastures with the addition of skim milk can form a large percentage of the total pig feed necessary.

In this respect the butterfat producer in areas of good rainfall where the growing period of pastures is a maximum is in a sound economic position to produce either pork or bacon pigs cheaply.

Grain Feeding of Pigs.

The following table shows the average quantity of feed necessary to obtain maximum growth rates. In these figures the quantity of feed only is mentioned (i.e., grain concentrates, etc.) without reference to the proportion of protein it should contain (Nutritive ratio) which is set out elsewhere in this publication.

Age.	Average live weight with full feeding.	Average feed consumption per day.	Comment.
Birth	2–2½ lb.	Nil.	Sows milk only for 3 weeks.
3 Weeks	12 lb.	V. small quantity	Commence creep feeding
4 Weeks	16 lb.	Small quantity	
6 Weeks	25 lb.	1 lb.	
8 Weeks	35 lb.	2 lb.	Wean at 8 to 10 weeks.
10 Weeks	47 lb.	2½ lb.	
12 Weeks	60 lb.	3 lb.	
14 Weeks	75 lb.	3½ lb.	
16 Weeks	90 lb.	4 lb.	
18 Weeks	107 lb.	4½ lb.	Porker Weight
20 Weeks	124 lb.	5 lb.	
22 Weeks	142 lb.	5 lb.	
24 Weeks	160 lb.	5½ lb.	Light Baconer.
26 Weeks	180 lb.	5½ lb.	
28 Weeks	200 lb.	6 lb.	Heavy Baconer.

The foregoing table of quantities cannot be taken as a hard and fast rule and the quantities may be varied according to the condition of the pigs: Over fatness to be avoided as much as low condition. Access to grazing will alter the feed requirements as suggested in the above figures which are for pigs fed mainly on grain and protein supplements, a costly procedure in recent years; the use of pastures and skim milk in our heavier rainfall areas can do much to reduce the feed costs which form such a high percentage of the production costs.

The Importance of Proteins.

The importance of an adequate supply of protein in the pig food cannot be too greatly stressed and this can be demonstrated by the results obtained in pig feeding trials at Muresk Agricultural College. The procedure was as follows:—

Twenty-four evenly matched weaners were divided into four groups and each group received a ration as follows—

Group 1. Mixture of wheat and meatmeal in a ratio of 2:1 for the first week, thereafter the proportion of meatmeal was gradually reduced until the final week when the ratio was 10:1.

Group 2: A mixture of wheat and meatmeal in a ratio of 9:1 for four weeks, the meatmeal then being reduced to 16:1 for the fifth week, and thereafter until the end of the trial the meatmeal was further reduced to a ratio of 24:1.

Group 3: A mixture of wheat and meatmeal in the ratio of 9:1 for four weeks after the commencement of the trial; from that time until the end of the experiment this group received wheat only.

Group 4: Wheat only.

The percentage of protein in the rations of the various groups is given hereunder:—

Group 1: 25.3% at the start then reduced gradually throughout the trial to 15.3%.

Group 2: 15.7% for the first four weeks, 14.0% for the fifth week and thereafter 13.2%.

Group 3: 15.7% for the first four weeks, thereafter 11.6%.

Group 4: 11.6%.

A mineral supplement (Di-calcic Lick) was included in the ration of each group and comprised 2½% of the total ration.

Greater quantities of food were consumed as the pigs grew, and owing to the greater rapidity of growth of Groups 1 & 2, their requirements for food became proportionately greater until at the end of the trial they were consuming slightly more than twice the amount used by Groups 3 and 4.

The average growth rates are shown in the accompanying graph.

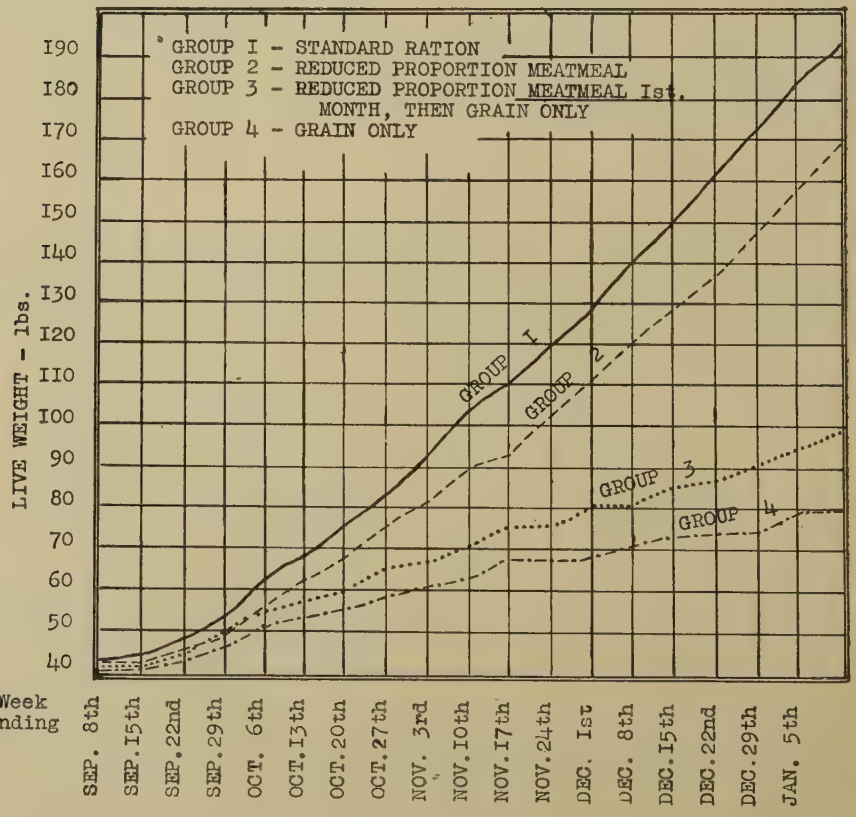


Fig. XVIII.

A clear indication of the value of an adequate protein supplement may be gained from the photographs below.

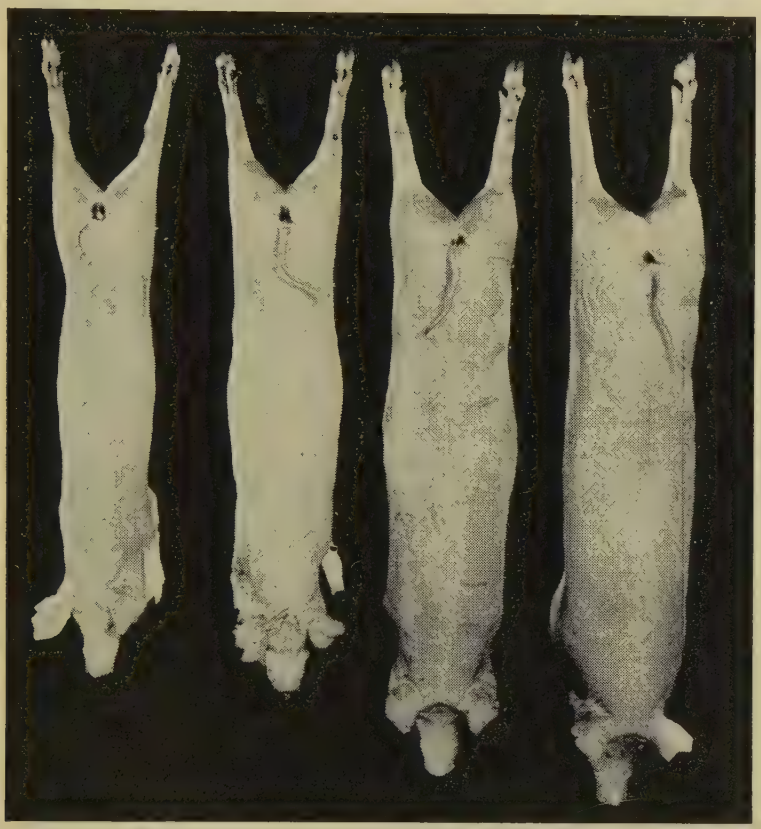


Fig. XIX.

An average carcass from each group. Group 1 to 4 from right to left.

The following table summarises the results obtained.

		Group 1.	Group 2.	Group 3.	Group 4.
Average weight at beginning of trial	lb.	41.8	41.3	41.2	40.5
Average weight at end of trial	lb.	193.7	165.3	97.0	79.8
Average gain per pig	lb.	151.9	124.0	55.8	39.3
Weight crushed wheat consumed per pig	lb.	414.7	453.8	285.8	262.5
Weight meatmeal consumed per pig	lb.	61.2	22.2	4.7	Nil.
Weight of feed per lb. of live weight increase	lb.	3.1	3.8	5.2	6.6
*Cost of wheat and meatmeal per pig		£3–19–4	£3–19–4	£2–8–5	£2–3–9
*Average cost per lb. live weight increase	pence	6.3	7.7	10.4	13.3

*NOTE : These costs are based on a price of wheat 10/– bushel and meatmeal £18 13s. 8d. per ton (long.)

The above results show that:—

1. The quickest rate of growth is the most economical. The butterfat producer who can graze his pigs on young pasture can be assured of a maximum growth rate and economise on the use of grain.
2. The best results are obtained when ample protein supplement is available, i.e., when the nutritive ratio is confined to the limits previously mentioned. The butterfat producer who matches his pig numbers to the skim milk available can be assured of ample protein in the ration.

Fig. XX.
The carcases in Fig. XIX were cut down. The sides are Groups 1 to 4 from right to left.

The Quality of Proteins.

The above trials demonstrate the value of using a protein concentrate of *animal* origin (i.e., meatmeal.) Later investigations showed that if *all* the protein was of vegetable origin less satisfactory results were obtained. Thus pigs raised on pasture alone without the addition of protein of animal origin may not grow satisfactorily. The dairy farmer, however, who has a surplus of animal protein concentrate (skim milk) which can be fed *in addition* to pasture and some grain is in a sound position of produce both pork and bacon carcases economically.

THE PREPARATION OF PIG FOODS AND OTHER FACTORS CONCERNED IN FEEDING AND MANAGEMENT.

Most pig foods require but little preparation. The following comments, however, will be of value.

Crushing Grain.—When small grains, such as wheat, oats or barley are fed it is an advantage to crush these to ensure maximum digestion and avoid whole grain being passed through the body.

The crushing need not be fine, it is sufficient to break the seed coat thus allowing the digestive juices to come freely into contact with the endosperm.

It has been claimed that losses up to 15% of the grain can be occasioned by feeding whole small grains.

Large grains, such as maize, need not be crushed as the pig is unable to swallow them whole.

Soaking Grain.—Observations indicate that soaking grain is not a sound practical procedure. If the grain were soaked long enough it would swell and the seed coat would soften and rupture thus, theoretically, aiding digestion. The labour involved and the risk of fermentation, however, make this practice undesirable.

Cooking Foods—Generally only garbage need be boiled as a protection against swine fever.

All other common foodstuffs used as pig feed are best fed raw, indeed there may be a lowering of the digestibility of the protein content in some foods when cooked.

Potatoes are the one notable exception. They should be boiled for best results.

Adding Mineral Supplements—An adequate mineral supplement for grain fed pigs is 1 lb. of salt and 1 lb. of finely ground limestone per 100 lb. of feed. Pigs having access to pastures or root crops will require less.

Vitamin Supplements—Under our normal systems of pig husbandry where pigs are not housed continuously and where they have access to ample sunlight, vitamin deficiency is rare.

Green feed, however, at the rate of ½ lb. per day per pig is an adequate vitamin A supplement.

Wet Foods—Generally wet foods, such as gruel or slop, are relished more than dry foods. More will be eaten and a quicker growth may be obtained. For this reason sows with litters are best given wet foods. The extra labour involved may not warrant the feeding of such food to all pigs.

Water.—Under our climatic conditions it is *essential* that ample supplies of good clean cool water be available at all times if good results are to be obtained.

Pig Wallows.—These are valuable in the summer months. This, however, should be a separate wallow with dry ground surrounding it. A badly drained and boggy pig yard does not constitute a wallow and only offers a breeding ground for disease.

Shade and Shelter.—Wherever possible pigs should be run in paddocks with ample shade. In some localities, particularly during winter, protection from wind is an important consideration.

Comparison of Various Foodstuffs as Pig Food.

Skim Milk.—Skim milk, as stated in other places in this article, is ideal as the protein rich supplement to the normal ration of pigs of any age. It is easily digested and supplies a protein of animal origin which is more efficiently utilised than proteins of vegetable origin. Skim milk is particularly valuable for pigs from, or before, the time of weaning until say, four months old and can be used profitably for pigs of all ages.

When only available in limited quantities it should be used firstly to give young pigs, and secondly, all pigs, a small daily allowance, rather than give some pigs several gallons each daily and leave none for other pigs.

Butter Milk.—The residue of the cream during the process of butter making is almost identical with skim milk both in composition and feeding value and hence can be used in the same manner as skim milk.

On many occasions, however, butter milk from factories contains a large proportion of wash water and is very dilute necessitating an adjustment in the quantities fed.

As pasteurisation is carried out in butter factories before the cream is churned there should be no risk of the buttermilk causing tubercule infections in pigs as could occur when feeding raw infected skim milk.

Whey.—Whey, the by-products of cheese manufacture, is relatively low in protein and cannot be used to replace either skim or butter milk entirely. The small proportion of protein it does contain however, is of good quality and can be used with advantage provided the total amount of protein in the ration is increased by the use of other protein rich material such as meatmeal or linseed meal.

Wheat.—Wheat alone cannot be considered a suitable food for pigs. It contains too high a proportion of starchy materials to protein and when fed alone tends to slow the growth rate and produce a larger proportion of fat to lean than is desirable.

However, when wheat is supplemented by suitable protein concentrates to produce a food having a narrower nutritive ratio excellent results may be obtained. Many pig feeding trials in this and other States have indicated that when wheat alone is fed approximately 4lb. of grain must be fed to produce 1lb. of live weight gain, whereas

if 7% of meatmeal (containing approximately 50% crude protein) is incorporated in the ration only 2½lb. of feed are required for each 1lb. live weight gain.

These figures will be of interest to the dairy farmer who has skim milk available when it is realised that one gallon of skim milk is equivalent to approximately ¾lb. meatmeal.

In the proportions suggested above, that is 7lb. of meat meal to each 93lb. of wheat, the dairy farmers could use approximately nine gallons of skim milk to the same quantity of wheat to produce a food of equal value. To state this in round figures, if 18 gallons of skim milk are used with each bag of wheat (180lb.) the food mixture will be generally suitable for growing pigs, except very young pigs which will do better with half again as much protein in the ration.

When feeding wheat (and other small grain) it should be coarsely crushed to facilitate maximum digestion.

Barley.—Both Cape and Malting barleys are good pig feeds when used in the same way as wheat (i.e., with a protein supplement—preferably of animal origin). Barley contains a little less protein than wheat (see Table—Chemical Analysis of Various Foodstuffs) and provision should be made for this when barley is used in place of wheat.

Oats.—Although oats is a palatable food its high fibre content makes it unsuitable when used in large quantities. In young pigs this fibre may give rise to scours. If oats is fed it should be ground and should not form more than 50% of the grain ration unless the pigs have access to good succulent pasture when the grain ration will be small.

Bran.—Owing to the high fibre content wheaten bran is not suitable when used in large quantities. It is a laxative food and can be used to advantage for brood sows at farrowing time. It is unsuitable for fattening purposes.

Pollard.—Wheaten pollard has approximately the same food value as the grains, being somewhat higher in protein, but the fibre content is fairly high. It is a suitable food when fed with protein concentrates of animal origin.

Meatmeal.—The best protein supplement where skim milk or buttermilk is not available. A safe food, easily assimilated and one which can be used to great advantage when mixed with the many common local foodstuffs whose common characteristic is a low protein content.

Root Crops.—Root crops alone are insufficient as a pig food but are a very welcome addition to any ration. They are mostly high in water content but the dry portion of many roots is similar in composition to the common cereal grains.

Over feeding on roots alone may lead to digestive troubles, and they should be fed in conjunction with other foods of a less watery nature and having a higher protein content.

Fruits.—Generally fruits are of little value as pig food on account of the high water content and low protein content.

Some fruit in the ration may increase the palatability. On the other hand the stones in some fruits, such as peaches whose stones frequently have a sharp spike can be dangerous and cause the death of pigs by injury to the alimentary canal.

In the following table the main characteristics of the more common pig foods are summarised together with an indication of their use. Taking one gallon of skim milk (10lb.) as the basis of the comparative weights of the other foodstuffs which may be used as indicated:—

FOODSTUFFS GROUPED ACCORDING TO TYPE AND VALUE AS PIG FOOD

Food.	Comparative Weight.	Remarks.
Foods rich in flesh forming nutrients:		
Separated Milk	10 lb. (1 gal.)	Use in conjunction with roots and other protein deficient foods.
Butter Milk	14	
Meat meal	¾	
Meat and bone meal	1	
Peas	1	
Linseed Meal	1	
Foods low in flesh forming nutrients:		
Barley	1	Use with skim milk or butter milk *or* use with meat meal and roots.
Wheat	1	
Oats	1	
Maize	1	
Pollard	1¼	
Bran	1¼	
Foods deficient in flesh forming nutrients:		
Whey	15	Supplement with skim milk and grains *or* meat meal and grains.
Swedes	9	
Carrots	8	
Potatoes (cooked)	4	
Pumpkins	12	
Apples	10	

Methods of Feeding.—For a pig feeding programme to be successful, quantity as well as quality of feed is important. Some observations on the quality of foods has been made in the preceding pages and it is appropriate to consider now the quantity of food necessary according to the age, stage of development and growth in order to finish the pigs with a desirable carcase conformation for the particular market, i.e., porkers or baconers.

Full feeding or restricted feeding can markedly affect the development, growth rate and the proportion of lean and fat tissue in the carcase.

Ample evidence has been gained from many feeding trials to indicate the advantages of full feeding on a suitable ration during the early life of any animal. If this high level of feeding be continued through-

out the life of the pig however there is a tendency for the animal to produce a larger proportion of fat at an earlier age than is found desirable from a marketing point of view. In order to avoid this overfat condition the food can be reduced to a lower level once porker weight has been reached (in the case of bacon pigs). The result of this practice is to delay the period of maturity and produce a lengthier and leaner pig which is suitable to the market.

This variation has been demonstrated by feeding four groups of bacon pigs according to the four systems indicated below:—

A.—Full feeding to porker weight. Full feeding from porker to bacon weight.

B—Full feeding to porker weight. Restricted feeding from porker to bacon weight.

C.—Restricted feeding to porker weight. Full feeding from porker to bacon weight.

D.—Restricted feeding to porker weight. Restricted feeding from porker to bacon weight.

The carcases produced from these four groups showed certain characteristics which may be summarised as follows:—

Summary of results obtained from various feeding levels—

A.—Short carcase, overfat, wasteful flap in belly.

B.—Well balanced lengthy carcase, fat and lean in correct proportion, good streak, i.e., an excellent carcase for the market.

C.—Carcase too fat, poor development of lean meat, wasteful belly.

D.—Slow development, too high a proportion of lean to fat.

It will be seen from the above results that the keynote of successful pig feeding is full feeding during the early stages of growth, followed by a period of somewhat restricted feeding which can be varied according to the progress made by the individual pigs, so that length of body and muscle development are encouraged and the natural tendency to lay on too much fat is discouraged.

Lastly it may be said that pig feeding should not be by rule of thumb. An appreciation of the food requirements according to age, attention to the condition of the pigs at all stages of their growth, and a knowledge of the market requirements are all of vital importance to the pig raiser.

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Internal Parasites of the Horse

J. SHILKIN, Senior Veterinary Surgeon

While actual losses from internal parasites are not of common occurrence in horses, much unthriftiness, debility and colic can be attributed to their presence in the intestines, particularly in young animals.

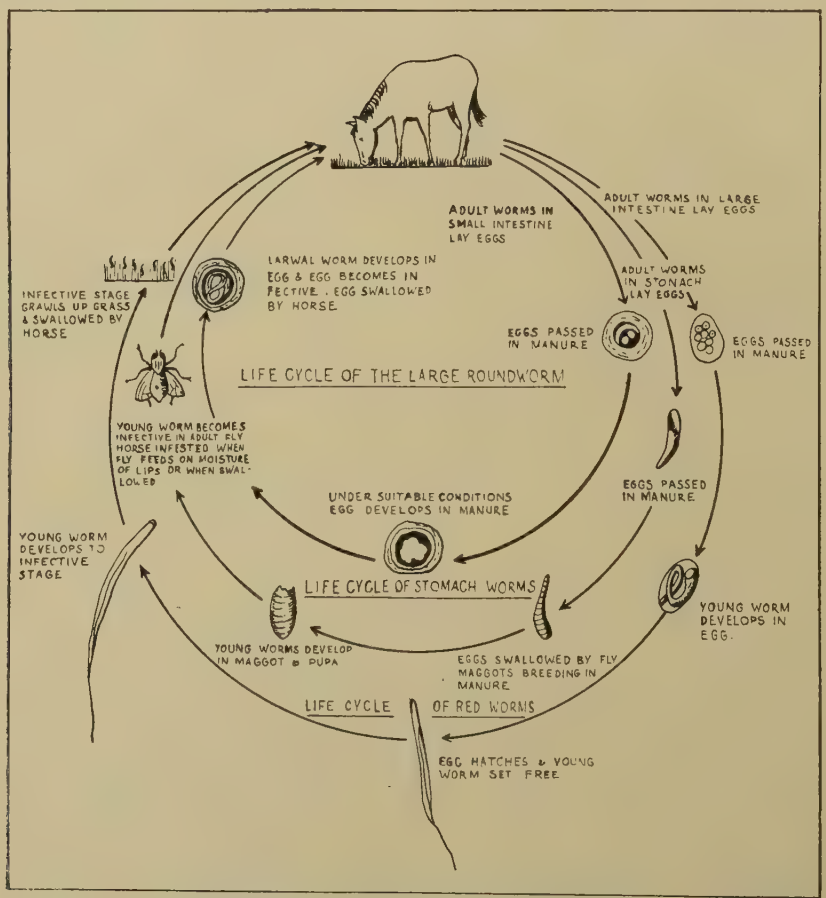
ADULT WORMS IN SMALL INTESTINE LAY EGGS
ADULT WORMS IN LARGE INTESTINE LAY EGGS
LARWAL WORM DEVELOPS IN EGG & EGG BECOMES INFECTIVE . EGG SWALLOWED BY HORSE.
ADULT WORMS IN STOMACH LAY EGGS
INFECTIVE STAGE CRAWLS UP GRASS & SWALLOWED BY HORSE
EGGS PASSED IN MANURE
EGGS PASSED IN MANURE
LIFE CYCLE OF THE LARGE ROUNDWORM
YOUNG WORM BECOMES INFECTIVE IN ADULT FLY HORSE INFESTED WHEN FLY FEEDS ON MOISTURE OF LIPS OR WHEN SWALLOWED
EGGS PASSED IN MANURE
UNDER SUITABLE CONDITIONS EGG DEVELOPS IN MANURE
YOUNG WORM DEVELOPS TO INFECTIVE STAGE
LIFE CYCLE OF STOMACH WORMS
YOUNG WORM DEVELOPS IN EGG.
YOUNG WORMS DEVELOP IN MAGGOT & PUPA
EGGS SWALLOWED BY FLY MAGGOTS BREEDING IN MANURE
LIFE CYCLE OF RED WORMS
EGG HATCHES & YOUNG WORM SET FREE

Diagram showing life-cycles of principal parasites.

Infection occurs through the horse swallowing the eggs or larvae which are present in the soil, water or grass. The different species then progress through their various life cycles ending with female worms laying eggs which are eventually passed out in the dung.

Although there are a large number of different species of worms which inhabit the intestine of the horse, only those few species which are considered of importance in Western Australia will be dealt with here.

1. RED WORMS *(Strongylus and Trichonema spp.)*

These are mostly reddish-coloured worms which inhabit the large bowel and caecum (blind gut). The larger variety *(Strongylus spp.)* vary in length from one to two inches and attach themselves to the gut wall by means of their mouths. The smaller types *(Trichonema spp.)* are about half an inch in length and lie free in the intestine.

Redworms *(Strongylus spp.)* (natural size).

The life history of all these species is not completely known, but the eggs passed in the droppings will hatch in about 24 hours provided conditions are suitable. The larvae then undergo development and are ready to infest the horse in about a week. At this stage, due to an enveloping sheath, the larvae are capable of surviving for long periods on the grass, although the majority will die in about three months. When the pasture is wet with dew or rain they are able to climb up the blades of grass and are swallowed by the horse as it grazes.

Once inside the animals the course followed depends upon the species. In the case of *Strongylus spp.* the larvae apparently move through the body in various directions and have been found in the lungs, liver, spleen, pancreas, lymph glands and various blood vessels. Their later course is unknown, but they eventually return to the large bowel where they develop to maturity and eventually lay eggs, so continuing the life cycle.

In the case of *Trichonema spp.* the larvae burrow into the wall of the large bowel, and remain there for some time, before returning to the bowel and developing to the adult stage.

Symptoms.—The condition induced by these worms is known as Strongylosis and is perhaps the most common and most serious parasitic disease affecting horses. The adults of *Strongylus spp.* feed on the intestinal wall and, as they are blood-sucking parasites, anaemia is a common symptom of the disease. The mucous membranes of the eyes and gums become pale and the animal becomes very weak. In some cases, dropsical swellings may be seen along the abdomen. Injury to the wall of the intestine may pave the way for bacterial infection.

Redworms *(Trichonemidae)* (natural size).

The larvae of the small species may cause the formation of nodules in the intestinal wall. These may give rise to digestive disturbances, resulting in soft and foul-smelling droppings, diarrhoea, and poor appetite. In advanced cases, the appetite may be depraved, causing the animals to eat bark, earth and rubbish. Outwardly the coat is rough, loss of condition is evident and the appearance generally dull and dejected.

One species invades the walls of certain arteries, particularly those supplying the large bowel and as a result of the invasion, the walls of the arteries becomes thickened and obstruct the flow of blood. It is believed that this obstruction may give rise to intermittent attacks of colic, but it should also be realised that such obstructions are frequently discovered in post mortem examinations of animals which have not suffered from colic at all.

2. LARGE ROUNDWORMS *(Ascaris equorum)*

These are large, yellowish-white worms up to 12 inches long usually found in the first half of the small intestine.

Eggs are passed out in the dung as with other species and under favourable conditions a larval worm is developed within the egg in about 14 days. After being swallowed, the egg hatches in the intestine, the larva bores into the intestinal wall, reaches the blood vessels and is carried to the liver. It eventually reaches the lungs via the blood stream again, and after a period of development, migrates into the windpipe, crawls into the mouth, is swallowed, reaches the small intestine again and develops to the adult stage.

The Large Roundworm *(Ascaris equorum)* (natural size).

Symptoms.—These parasites are most serious in young animals, causing digestive troubles, enteritis, intermittent diarrhoea, colic, etc. In very heavy infestations portions of the bowel may be almost completely blocked, leading to rupture of the bowel wall.

Damage to the lung tissue resulting from the presence of the larvae may lead to pneumonia.

3. LARGE STOMACH WORMS *(Habronema spp.)*

There are three species of these worms, varying in size from half to one inch in length.

Eggs containing minute larvae are deposited in the stomach and eventually passed out in the droppings. No further development occurs unless the eggs are swallowed by the maggots of certain species of flies, particularly the house fly, stable fly and bush fly. Once the maggot develops into the adult fly, the larval worms make their way into the proboscis (sucking organ) of the fly which in turn disgorges the larvae into saliva around the horses lips. Many of the larvae are then swallowed by the horse. Upon reaching the stomach they then develop to the adult stage.

Large Stomach Worms *(Habronema spp.)* (natural size).

Symptoms.—Whilst Habronema infestation is very common in this country, it is not considered of any great economic importance. The smallest species is possibly the most serious as it burrows into the stomach wall, causing the formation of fibrous nodules and possibly causing digestive disturbances.

There is also an external form of Habronema infestation which may cause trouble when infested flies feed on sores or other moist places, such as the sheath, penis, or mucous membranes of the eye, etc. The larvae may be set free and commence to burrow. Growths produced by the burrowing are difficult to heal and such growths on the eye, penis and sheath, particularly, are probably quite often confused with true cancerous growths. The condition frequently encountered in northern parts of Australia and commonly referred to as Swamp Cancer is most probably one of Habronema infestation.

4. SMALL STOMACH WORMS *(Trichostrongylus axei)*

Has not been reported in this State and, in any case, is not regarded as of any great importance.

5. PIN WORMS *(Oxyuris equi)*

These worms are commonly present in horses in this State. They vary in colour from white to grey or brown, and may be up to six inches in length including the long narrow tail. They occur in the large bowel.

The mature female worm deposits her eggs in clusters round the anus of the horse, but occasionally is passed out of the animal and lays the eggs in the droppings. A small larva develops inside the egg, which then hatches only after being swallowed. The larvae then develop to maturity in the large bowel.

Pinworms *(Oxyuris equi)* (natural size).

Symptoms.—These are of importance mainly on account of the irritation produced round the anus by the female when depositing eggs. This itching causes animals to rub their tails against trees, walls, fences, etc.

6. TAPEWORMS

Three different species of tapeworms infest the horse, the smallest being from a quarter to two inches in length, the next two to three inches, whilst the largest and most common may measure up to 30 inches long and one inch wide. The smallest species has not been recorded in Western Australia.

Whilst it is known that tapeworms generally, require the assistance of an intermediate host such as an insect, mite or slug and that each type of tapeworm has its own specific host, the complete life cycle of these particular worms is not completely known.

They are generally found in the small intestine, but may inhabit the large intestine as well.

The Large Tapeworm of the Horse (natural size).

Symptoms.—Even heavy infestations with these parasites are not regarded as of any great consequence in Australia. Reports from other countries have ascribed such symptoms as general unthriftiness, rough coat and digestive disorders to their presence, but in Australia at least, these symptoms are usually considered to be due to round-worm infestation.

7. BOTFLIES *(Gastrophilus spp.)*

Three species of botflies, the common botfly, the throat botfly, and the nose botfly, are known to attack the horse, and all three species have been recorded in Western Australia.

The adults are two-winged insects, the common botfly being brownish grey with mottled wings and white face. The throat botfly is smaller and has a reddish thorax with a black band across the abdomen, and the nose botfly is smaller again.

The **common botfly** deposits her eggs on the hairs of the mane, chest, shoulders, and legs, mostly during the late summer and autumn. The eggs are yellowish in colour and are attached to the hairs for about one-third of their length. Though the eggs are ready to hatch in about seven days they may remain unhatched for months. Hatching only occurs when they are rubbed or licked by the horse.

The **throat botfly** deposits her eggs on the hairs under the jaws mainly during the late spring and early summer. They are fastened to the hairs for about two-thirds of their length, each egg being attached singly to one hair. Friction is not necessary for hatching to take place.

Bots (natural size).

The **nose botfly** deposits her eggs on the hairs of the lips. The eggs are black and stalked and are aided in hatching by the moisture round the lips.

On hatching, the larvae of all species enter the mouth, bore their way beneath the mucous membranes of the mouth and tongue and eventually make their way to the stomach. Here they attach themselves to the wall by means of a pair of strong hooks on their mouth-parts. After a period of about eight to 12 months in the stomach they reach maturity and pass out in the dung. Once on the ground, the bots burrow into the soil for a short distance. In a few days the outer skin hardens to form a protective coat for the pupa developing inside. In from three to 10 weeks the adult fly emerges.

Adult Botflies: Left, Common Botfly; centre, Throat Botfly; right, Nose Botfly.

Effects.—The most important effects of botflies are those brought about by annoyance and worry at the time of egg-laying. In an attempt to prevent the flies from laying their eggs, horses will keep up constant movement and so obtain insufficient rest.

It is generally considered that the presence of the bots in the stomach even in large numbers does not exert any seriously harmful effect on the animal. It is possible that the mouth hooks may give rise to some inflammation where they are attached and that large numbers may act as an obstruction to the passage of food.

TREATMENT OF INTERNAL PARASITES

For the treatment of the Redworms *(Strongyles and Trichonema)* and the large Roundworms *(Ascaris equorum)*, phenothiazine is the most efficient drug and it has largely replaced some of the older and less efficient methods previously employed.

The phenothiazine powder is given in the feed in the following doses:—

Draught horses	1 oz.
Light draughts and saddle horses	¾-1 oz.
Yearlings and ponies	½ oz.

As phenothiazine in full doses may at times unaccountably cause ill effects, even death, the danger can be minimised by dividing the dose into three or four equal parts and giving one part daily for three or four days. Most horses will consume the treated food, particularly if a little molasses is added, and prior starvation is unnecessary. Bran mashes should be fed before, during and after treatment unless horses are on green feed and the bowels are free. The urine becomes a reddish colour when exposed to the air, and treated horses should be spelled until the colour of the urine returns to normal, usually in four or five days. Following treatment, horses should be run in a paddock which has carried no horses for a few months.

The **large stomach worm** *(Habronema spp.)* is not often treated. As the smallest of the species is located in nodules in the stomach, treatment is not effective. Carbon bisulphide is fairly effective in removing the other species, but as it can be dangerous in inexperienced hands and the method of administration is difficult, treatment of this nature is best carried out by a veterinarian.

Carbon tetrachloride may also be used and is given in a dose rate of 25 c.c. for every 500lb. weight in one to two pints of liquid paraffin. The animal should previously be starved for from 24 to 36 hours.

Treated animals should be well fed subsequently until recovery is complete and the addition of two grains of iron sulphate daily will assist in relieving the anaemic condition induced by the worms.

A second treatment about three months later may be advisable in order to remove those worms which have been wandering through the body.

The pin worm *(Oxyuris equi)* is best treated with oil of chenopodium, 4 c.c. for every 250lb. weight. This should be given in one to two pints of equal parts of raw linseed oil and liquid paraffin. The animal should be starved for 24 to 36 hours prior to treatment and if the bowels have not moved within 24 hours following treatment, another dose of oil should be given. Oil of chenopodium should not be used for pregnant mares.

The oil of chenopodium has the effect of removing the worms from the upper part of the large bowel. To remove the females from the lower part of the bowel an enema of quassia infusion may be given.

As the egg clusters round the anus cause irritation they should be washed away with soap and water and then either mercuric or carbolic ointment applied.

The treatment of **tapeworms** is not usually attempted.

The treatment of **bots** is best carried out with carbon bisulphide at the rate of 6 c.c. for every 250lb. weight, with a maximum of 24 c.c. This drug must be given either in a capsule or by stomach tube, but experience is required for both methods of treatment. The animals should be starved for from 18 to 24 hours prior to treatment and no food or water should be given for three or four hours after treatment. Treatment should be carried out about June when the majority of bots will have reached the stomach.

PREVENTION OF PARASITIC INFESTATION

Prevention is much more important in the control of parasitic diseases than medicinal treatment, as prevention measures thoroughly carried out will eliminate or at least reduce the necessity for medicinal treatment.

The chief source of infestation in most cases is the manure. Whilst it is difficult to prevent contamination of the pasture, wherever manure can be conveniently collected, such as from stables and yards, this should be carried out regularly. The disposal may present a problem, but it is possible to treat it so that flies are prevented from breeding in it. One method is to spread it out thinly on farm land so that drying occurs rapidly, and it ceases to become an ideal breeding-ground for flies. This method is, of course, not satisfactory in wet weather. Horses should not be run on land where this is carried out. Another method is to store it in compact heaps firmed down by beating the manure with shovels, and the outer layers of the heap should be turned into the centre of the heap at frequent intervals. The heat generated inside the heap kills any eggs or larvae that may be present.

Feed-boxes should be raised above the ground and hay should be fed in racks and not thrown on the ground.

Bedding should be changed frequently.

Clean water should be provided in troughs and where possible horses should not be permitted to drink from shallow, stagnant pools.

Pastures should be spelled for at least three months, but whilst spelling from horses may be grazed by cattle or sheep.

Overstocking, of course, increases the contamination of pastures and should be avoided.

Adequate feeding plays a big part in reducing trouble from worm infestation, and it is common for animals to have relatively heavy infestations without showing any obvious symptoms so long as feeding and nutrition generally are good.

DIAGNOSIS OF PARASITIC INFESTATION

Diagnosis is best carried out by examining the droppings microscopically to detect the presence of worm eggs. For this purpose the material must be reasonably fresh, preferably not more than a day old, when it is received at the laboratory.

Failing this, diagnosis must be based on the symptoms, and in some cases by the presence of adult worms which may be passed in the manure.

Control of Clearing; Further Notice to Farmers

G. H. BURVILL, Commissioner of Soil Conservation

Farmers and land owners in the North-Eastern and Eastern Soil Conservation Districts, are reminded that no clearing of land is permitted without permit from the Commissioner of Soil Conservation.

The North-Eastern Soil Conservation District embraces the Road Board areas of:—Koorda, Mt. Marshall, Mukinbudin, Westonia, and Yilgarn.

The Eastern Soil Conservation District covers the Road Board areas of:—Wyalkatchem, Kununoppin-Trayning, Nungarin, Kellerberrin, Merredin, Bruce Rock, Narembeen, Kondinin, and Kulin (eastern part).

The Control of Clearing regulations have been made under the provisions of Section 22 of the Soil Conservation Act, 1945. Persons wishing to clear land are required to give three months' notice in writing to the Commissioner of Soil Conservation on the prescribed form, and may not commence clearing without permission from the Commissioner.

The regulations apply not only to virgin land, but also to previously cleared areas on which a re-growth of seedlings, suckers, coppice and shrubs has developed, and where such land has not been cultivated for at least five years.

Farmers are urged to make their applications for any land clearing which they intend to do at the earliest opportunity, so that arrangements for inspections can be carried out most efficiently.

Experience over the past year has shown that too large a number of farmers do not forward their notice and application for permit until within a few weeks of the date when they wish to start clearing, whereas the regulations require that three months' notice shall be given.

Application forms are available from the various Road Board offices in the districts concerned, or may be had directly by application to the Commissioner of Soil Conservation, Department of Agriculture, Perth. It will help if the position of the homestead and telephone exchange and number are given, particularly when the land to be cleared is not on the home farm.

For the Farm Bookshelf

Book Reviews by "Martingale"

Two recent additions to the Australian Agricultural and Livestock Series, published by Angus and Robertson, of Sydney, are now on sale in Perth bookshops and should prove particularly popular with practical farmers and agricultural science students in this State.

"DISEASES OF POULTRY"

By T. G. HUNGERFORD, B.V.S.c., H.D.A.

The author of this book should need little introduction as he issued an earlier edition under the same title in 1939. He is a practising veterinarian and a former N.S.W. Government Veterinary Officer specialising in poultry diseases, also a lecturer on this subject at the Faculty of Veterinary Science, University of Sydney.

The widespread popularity of the 1939 edition should be eclipsed by the latest publication in which he has brought his earlier work up to date with a mass of information on the latest developments in poultry disease control.

The causes of the diseases, their diagnosis by symptoms and post-mortem examination are dealt with in excellent detail with a wealth of illustrations. In the main, the book is written for laymen, but a certain amount of technical detail has been included so that it has value as a reference work for stock inspectors and veterinarians.

The frontispiece of the book is a coloured folding cut-out of a bird showing the exterior points, skeleton, muscles and internal organs with a numbered key. In a preliminary chapter, the author discusses the economic aspects of diseases as they affect the commercial poultry farmer, and the factors which predispose a flock to disease epidemics. He describes the method of conducting a post-mortem examination and details abnormalities of the various organs which may provide clues to diagnosis.

A chapter on feeding and management gives a brief but comprehensive outline of these aspects of successful poultry rearing before the actual disease section is dealt with.

Subsequent chapters cover such subjects as:—Roup Diseases; Diseases of Chickens and Young Stock; Paralysis and Leg Weakness; Diseases in which Diarrhoea is a Common Symptom; Deficiency Diseases; Poisoning; Internal and External Parasites; Hatchery Problems; Diseases of Ducks and Turkeys; Disinfection and Fumigation, etc.

A lengthy glossary of scientific terms is remarkable for the comprehensive definitions attached for the benefit of the layman. The book is comprehensively indexed for easy reference and its 427 pages are well printed on good paper carrying about 90 illustrations in line and half-tone. An attractive full-cloth cover makes for durability, and altogether it is a volume that would be an asset to any farmer's bookshelf.

["Diseases of Poultry," by T. G. Hungerford. Retail price, 63/–. Our copy from the publishers, Angus & Robertson, Sydney, N.S.W.]

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2.P.C.

"PIG-RAISING IN AUSTRALIA"

By L. A. DOWNEY, H.D.A.

With more than 20 years of practical experience as a Government pig expert in New South Wales, Queensland and Victoria to his credit, the author is well equipped to write an authoritative book on this important branch of Australia's livestock industry—and the need for a good up-to-date Australian textbook on pig-raising has long been apparent.

This new volume is the latest addition to Angus & Robertson's "Australian Agricultural and Livestock Series," and has all the outward earmarks of excellence in clear print, attractive illustrations and colourful full-cloth binding, which we have come to identify with this helpful series.

The contents cover a wide range of subjects on breeding, feeding, housing, managing and marketing pigs—material selected from the author's wide personal experience and incorporating much information gathered from other practical pigmen and from the research and experimental fields.

The author emphasises the point that the pig's place in the farm economy is "a machine to convert grain, milk, pasture, etc., into pork, which, in its several forms, is used as food for humans." He underlines the statement that in pig-raising, more than in any other kind of livestock farming, the results directly reflect the human factor—the work of the man on the job. The need for sound budgeting is stressed, and the author deals briefly but effectively with the different kinds of pig-raising practised in this country.

Chapters trace the development of the various commercial pig breeds and describe their points and characteristics. This section carries good half-tone illustrations of the main breeds.

Feeds and feeding naturally occupy a large section of the book and there is an informative chapter on housing and appliances such as self-feeders, hurdles, farrowing-pens, loading-races, etc., carrying well-drawn diagrams.

The management section discusses the various kinds of tattooes, brands, ear-tags and other identification methods, the handling of boars and sows, ringing, castration and similar subjects. The whole book is written in plain straightforward language and economy in the text is achieved by the large number of photographic illustrations and diagrams. There are 150 pages in the book including a comprehensive index and it is a welcome addtion to a branch of Australian livestock literature which has received but little attention since "Potts on Pigs" was written many years ago.

["Pig Raising in Australia," by L. A. Downey, H.D.A. Retail price, 35/–. Our copy from Albert's Bookshop, Forrest Place, Perth.]

By Authority: WILLIAM H. WYATT, Government Printer, Perth